SCIENCE 24

Module 7: Energy in Action

Distance Learning

Alberta EDUCATION

Science 24

Module 7

ENERGY FORMS

Distance Learning

Alberta EDUCATION

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Teachers (Science 24)	✓
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Other	

Science 24
Student Module
Module 7
Energy Forms
Alberta Distance Learning Centre
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Welcome to Module 7!

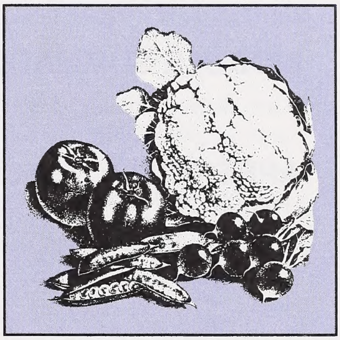
We hope you'll enjoy your study of Energy Forms.

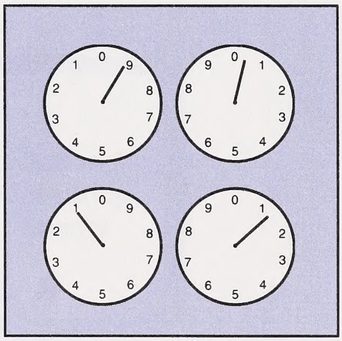
To make your learning a bit easier, a teacher will help guide you through the material.

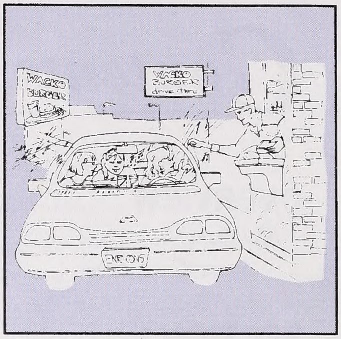
So whenever you see this icon,

turn on your audiocassette and listen.

Contents





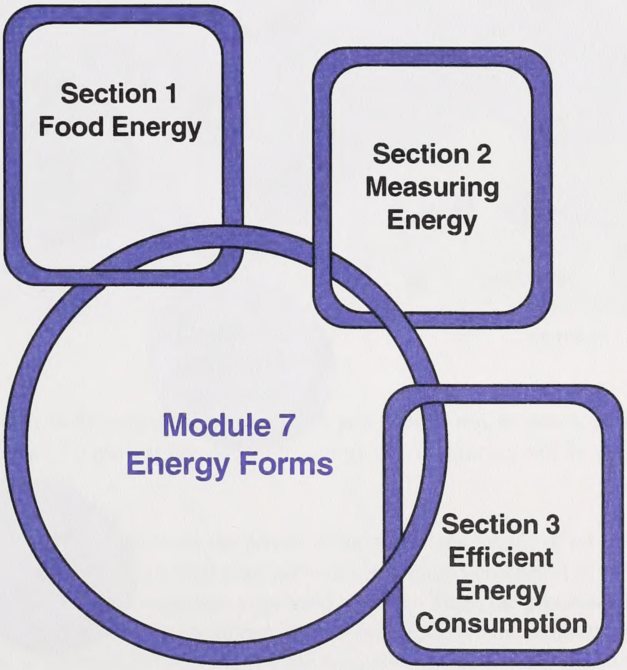

WACKO BURGER
WACKO BURGER drive-thru

OVERVIEW

Did you ever experience the frustration of having your battery-powered calculator quit while you were writing an important exam? Or, did your battery-powered ghetto blaster ever quit just when you needed it the most? Didn't you wish they were solar-powered?

You are already aware of the fact that all machines are dependent on a source of energy, but have **you** ever experienced that same run-down, tired, or burned-out feeling? Could this mean that you are running out of energy? What do you do to restore your body's energy?

In this module you will learn that the source of energy your body needs, for all its life activities, is stored in the food you eat. You will first investigate how energy is stored in the food and how your body converts this food back into usable energy. You will then analyse how this energy can be measured, and finally you will become aware that your lifestyle depends on an efficient and careful consumption of this energy. In the end you should realize that you and your environment are really solar-powered.

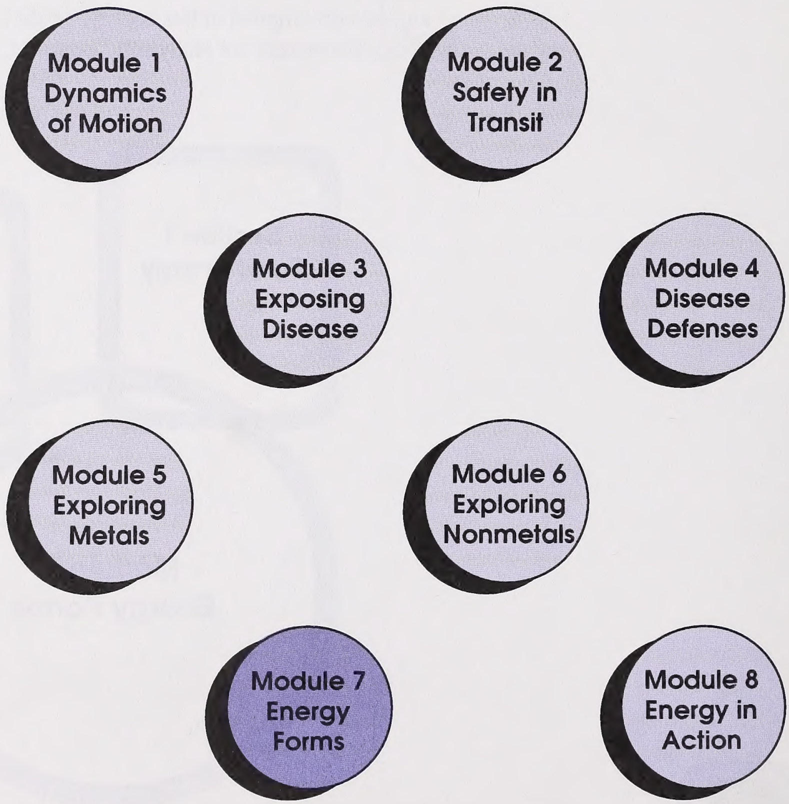


Evaluation

Your mark in this module will be determined by your work in the assignment booklet. You must complete all assignments. In this module you are expected to complete three section assignments. The mark distribution is as follows:

Section 1 Assignment	**30 marks**
Section 2 Assignment	**45 marks**
Section 3 Assignment	**25 marks**
TOTAL	**100 marks**

Course Overview



Section

1 Food Energy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Where does all the energy come from that you need to run, to dance, or to do any activity? To answer this question, energy and its sources will be considered in greater detail.

In this section you will study the power of the sun as the source of all energy. The energy you receive for all your activities is seldom considered as solar energy unless you also consider your food sources. Thus, the processes through which energy from the sun is stored in food, how food is broken down through digestion to release food energy, and the conversion to cell energy from food energy will be analysed. As well, you will also assess what foods are required for a balanced diet.

Activity 1: Sun Power

energy – the capacity for doing work

work – the application of a force through a distance

force – a push or pull in a certain direction

The energy you have comes from the food you eat – whether the food is from the sea, garden, farm, or supermarket. But where does this food energy come from? Before you investigate the sources of energy, you must first know what energy is.

Energy can be considered as the ability to do work. Furthermore, **work** is done when an object is pushed or pulled through a distance. Is this contrary to the common belief that the time and effort you spend doing homework is actually work?

The push or pull needed to do work can be called a **force**. Thus, if you do work on an object by applying a force to move the object through a distance, then you must be using up energy.

There are many different kinds of food products available at your local grocery store. Some foods have a high energy content, whereas others contain very low levels of energy. If you were concerned about doing work, would you choose foods that are high or low in energy?

1. Name four foods that are high in energy.

   ____________ ____________

   ____________ ____________

2. Name four foods that are low in energy.

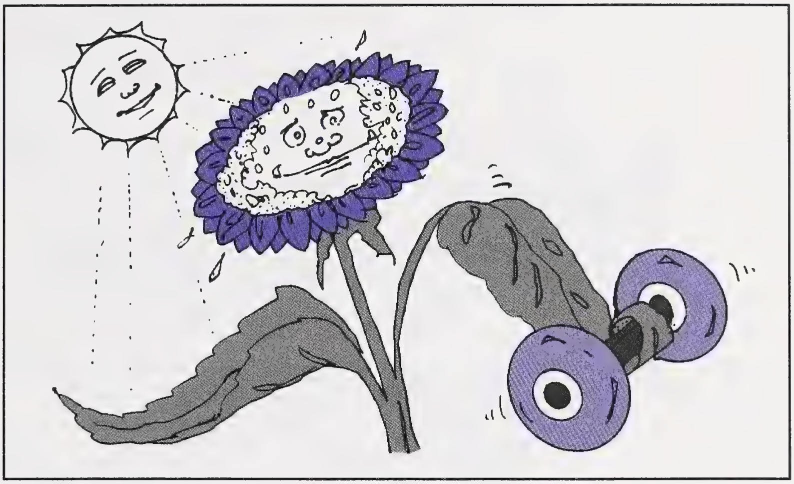
   ____________ ____________

   ____________ ____________

3. Where do you think the food you eat gets its energy from?

   ____

   ____



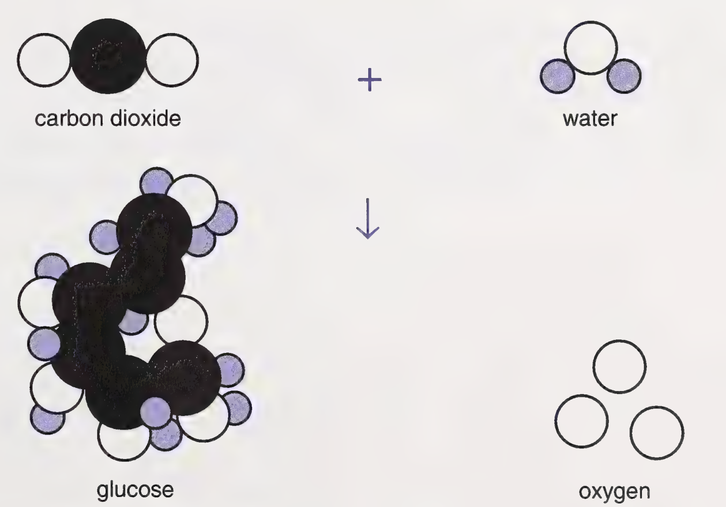
photosynthesis – a process by which green plants produce carbohydrates and oxygen from carbon dioxide and water in the presence of light and chlorophyll

carbohydrate – a molecule such as sugar, starch, or cellulose that contains carbon, hydrogen, and oxygen

Recall that green leaves in plants contain chlorophyll which acts like solar collectors. The chlorophyll captures the sun's radiant energy and converts it into food energy. This process is called **photosynthesis**.

Photosynthesis is a process by which plants use carbon dioxide (CO_2) and water (H_2O) in the presence of chlorophyll and sunlight to produce sugar or starch ($C_6H_{12}O_6$) and oxygen (O_2) as illustrated in the following diagram. Sugar and starch are also called **carbohydrates**.

The Process of Photosynthesis



4. Write the process of photosynthesis as a chemical word equation by using the given names for the chemicals involved. Show the reactants used and the products that are formed.

____

____

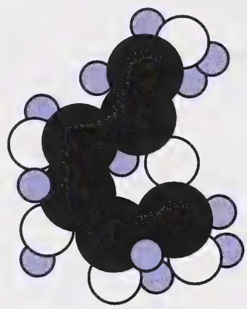
____

____

glucose – a simple sugar occurring naturally in fruits, honey, etc. It is the number one source of energy for practically all living organisms.

The sugar that is produced during the process of photosynthesis is called **glucose** and is shown in the following graphic.

Glucose Molecule



glucose

starch – complex molecule occurring naturally in potatoes, cereals, etc. made from many sugar molecules

When many glucose molecules combine, they produce a very large molecule called **starch**. A starch molecule contains hundreds of individual glucose molecules. The molecules of starch are more complex compared to glucose; therefore starch stores more energy than does the simple sugar glucose.

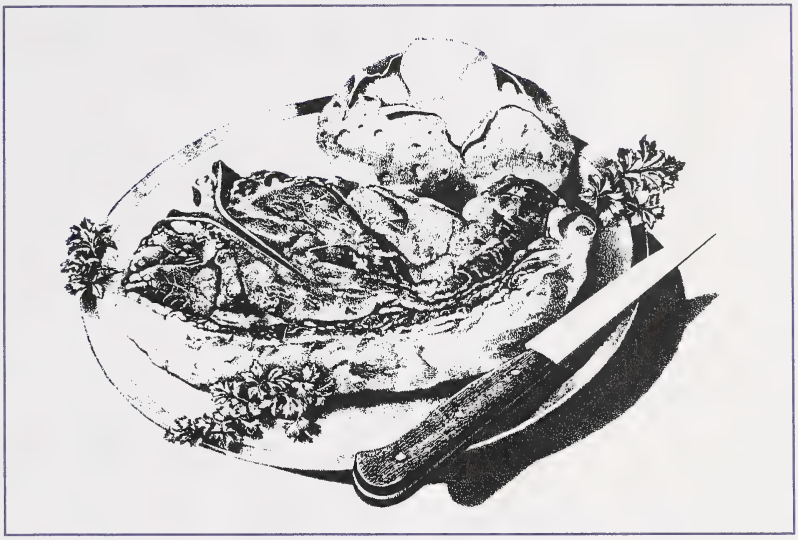
5. Name four foods that are classified as starch.

____

____

____

____



6. a. What things in the preceding diagram receive their energy directly from the sun by making their own food?

____

____

b. What things in the preceding diagram receive their energy from the sun indirectly?

____

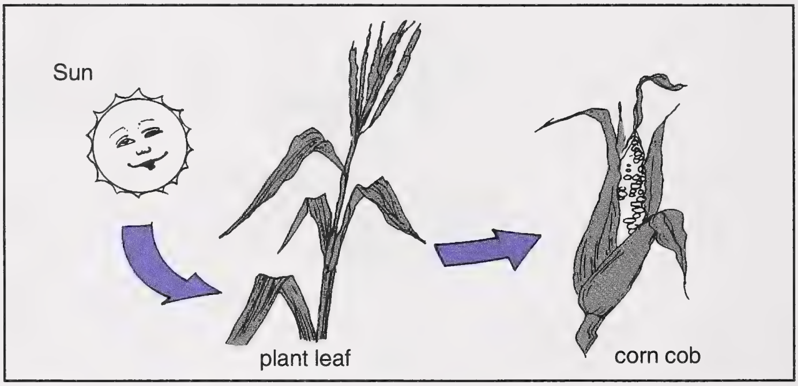
____

chemical energy – energy needed to hold atoms together when they make molecules

The energy contained in plants is known as **chemical energy**. When you eat plants the chemical energy is transferred to you.

7. Suppose you eat a ham, lettuce, and tomato sandwich. Starting with the sun, describe the energy transfers that were involved in your meal.

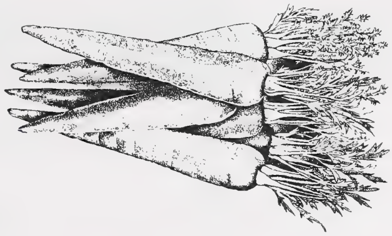
The following diagram shows the transfer of energy from sunlight, to the sugar produced in a plant leaf, to the place where the energy is stored in a corn cob.



Have you ever eaten fresh picked corn on the cob? Fresh picked corn tastes sweeter than over-ripe corn because the glucose molecules have not yet converted themselves into starch. Glucose is a sweet sugar compared to starch, which is bland.

8. If you chewed a slice of bread or unsalted soda crackers for about ten minutes without swallowing, you may detect that they become sweet tasting. Suggest how the change could have occurred.

Carrots, peas, and potatoes, to mention a few, are foods that obviously originated from plant life. Today, many modern foods do not look at all like the specific plant from which they came.



9. Suggest the possible plant that each of the following foods originated from.

a. spaghetti	____________	e. coleslaw	____________
b. candy floss	____________	f. margarine	____________
c. ketchup	____________	g. pretzel	____________
d. mustard	____________	h. chocolate	____________

Check your answers by turning to the Appendix, Section 1: Activity 1.

Investigation: Starch Energy

Do either Part A or Part B. If you have access to school laboratory facilities, do Part A. If you do not have access to school laboratory facilities, do Part B.

Part A

In this investigation you will examine some foods that have a high level of starch.

Materials You Need

- hammer and metal surface or mortar and pestle
- tincture of iodine or iodine indicator solution
- seed samples – corn, popcorn, dried peas, lentils, wheat, rice, tapioca, etc.
- pinch of baking flour
- pinch of cornstarch
- two sheets of white paper

Steps to Follow

STEP A

Choose three different types of seeds. For example, you could choose corn, wheat, and navy beans.

STEP B

Label one white paper according to the type of seed that is to be placed upon it.

corn	wheat	beans

STEP C

Crush each type of seed separately using a hammer and a metal surface or a mortar and pestle. Place the crushed seeds in their appropriate columns on the white paper.

STEP D

Put one drop of water and one drop of iodine on each of the seed samples. Observe the colour changes.

STEP E

Label one half of the other white paper as flour and the other half as cornstarch.

Place the samples of flour and cornstarch in their appropriate column.

flour	cornstarch

STEP F

Add a drop of water and a drop of iodine to each sample.

Observe the colour changes.

Observations

10. Record your data in the table.

Type of Seed or Substance	Original Colour	Colour with Iodine Indicator
flour		
cornstarch		

11. Place a drop of water and a drop of iodine on a plain white sheet of paper. What colour changes do you see?

____

____

Conclusions

As was observed in the investigation, flour and cornstarch both contain starch. The same observation was seen to happen when water and iodine were placed on a normal sheet of white paper. Starch is added in the production of paper to give it a better and smoother texture.

12. What evidence supports the statement that starch is added to paper?

____

____

13. From your observations, what conclusions can you make about the test for starch?

____

____

Check your answers by turning to the Appendix, Section 1: Activity 1.

Part B

In this investigation you will research information from other sources that will enable you to determine whether foods have starch in them or not. It will be helpful to know that starch is sometimes referred to as a carbohydrate. The structure of carbohydrates is based on the carbon atom bonded to water molecules.

14. Place the items from the list in the appropriate columns.

- soda cracker
- celery
- white turkey meat
- cheese
- egg
- vegetable soup
- potato chip
- white cake
- coffee
- ripe banana
- bacon
- lettuce

High Starch	Low or No Starch

Check your answers by turning to the Appendix, Section 1: Activity 1.

Recall that plants use sunlight energy to make the simple sugar glucose by the process of photosynthesis. The plant then converts the glucose molecules into starch molecules. Starch is not the only substance that is converted from glucose. Oil molecules are also produced in this conversion from glucose.

translucent – substance through which light passes but through which one cannot see through clearly

Investigation: Oil in Plants

In this investigation you will examine some plant products that contain oil. When oil is placed on paper, the paper becomes **translucent**. That is, the paper allows light to shine through but images cannot be distinctly identified.

Materials You Need

- brown lunch bag paper
- cooking oil – e.g., corn, peanut, canola, vegetable
- a peanut
- other nuts, e.g., walnuts, macadamia, almonds
- hammer
- hard surface or mortar and pestle

Steps to Follow

STEP A

Place a drop of cooking oil on the brown paper and observe what happens.

STEP B

Crush the peanut using a hammer and metal surface or mortar and pestle. Place the crushed peanut on a sheet of brown paper.

STEP C

Rub the crushed peanut into the brown paper and describe what happens to the paper.

STEP D

Repeat steps B and C for another two other types of nuts.

Observations

15. Record your data in the table.

Type of Oil or Nut	Effect on the Brown Paper
peanut	

Conclusions

16. From your observations, what conclusion can you make about peanuts and other types of nuts?

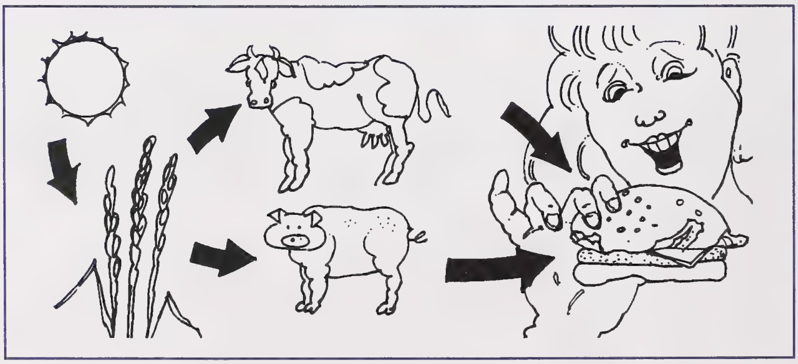
____

____

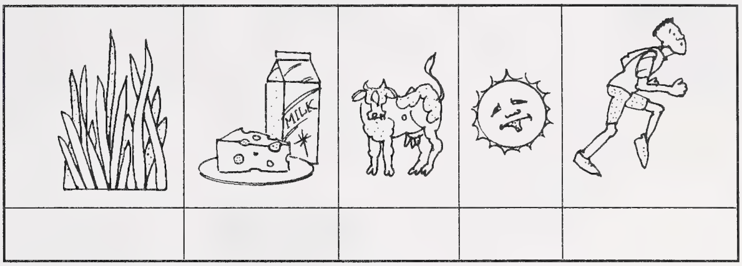
____

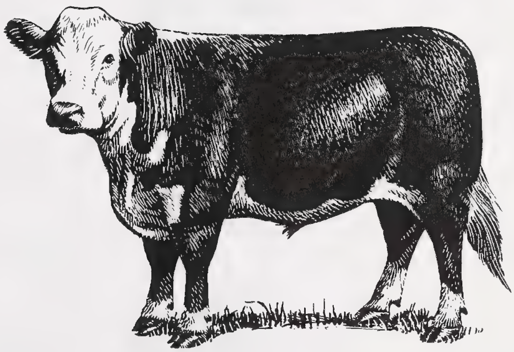
Check your answers by turning to the Appendix, Section 1: Activity 1.

Animal food products depend on one more energy transfer before you eat them. The meat is produced when animals eat grains and grasses which contain chemical energy. Eggs and milk contain energy that has also been transferred from the animal's diet into food that humans eat.



17. Examine this series of sketches. Place a number under each box to show the correct order of energy transfer.





18. Draw a simple energy transfer that includes the following: barley, a woman, Hereford steer, sun, T-bone steak.

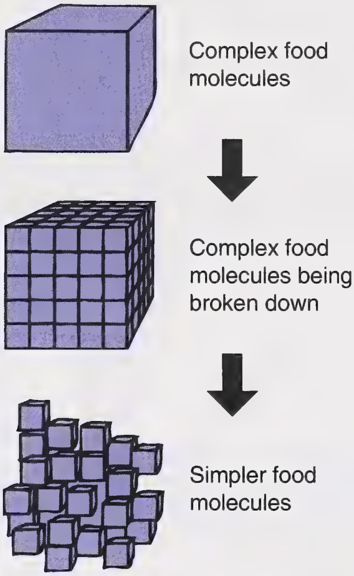
Check your answers by turning to the Appendix, Section 1: Activity 1.

In this activity you have been able to trace the source of energy of the food you eat back to the sun. In the next activity you will study how your body breaks down foods into usable energy.

Activity 2: Your Digestive System

How does your body obtain energy from the foods you eat? What happens to change your breakfast cereal into the energy that powers your body?

Until the more complex molecules are broken down into simpler molecules, energy cannot be released from food. In this activity you will investigate how this occurs.

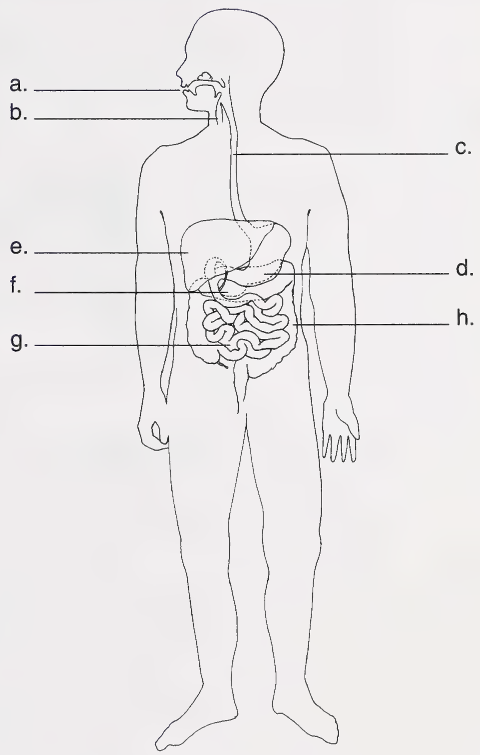


The first step in the breaking-down process is to digest the food. In this process large particles of food are liquified. Then the complex food molecules are split into simple forms. It is these simple forms that can be transferred to and absorbed by the cells in the body. This first step occurs in a body system called the digestive tract.

Do you remember which organs make up your digestive tract? A biology text or other reference may be useful for this activity.

1. Use the following diagram to identify the organs of the digestive system.

Your Digestive System



a. ______

b. ______

c. ______

d. ______

e. ______

f. ______

g. ______

h. ______

Try to imagine the smell and taste of fresh cinnamon buns. Does the thought make you hungry or make your mouth water?

Digestion begins even before food enters your mouth. Just smelling or thinking about food can start the flow of saliva in your mouth.

2. Why is your favourite food very tasteless when you have a cold?

____

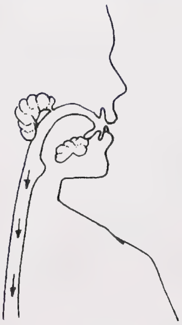
____

3. What is the function of saliva?

____

____

Breaking Up Starch Molecules



enzyme – a substance, formed in plant and animal cells, which speeds up or slows down a chemical reaction without being chemically changed itself

Biting and chewing food changes it into smaller particles. Saliva contains an **enzyme** which starts the breakdown of starch molecules into the simple sugar molecules (glucose). Water within saliva helps the food move down your esophagus. Muscles contract in the esophagus enabling the food to move into the stomach.

4. What is an esophagus? What is its purpose?

____

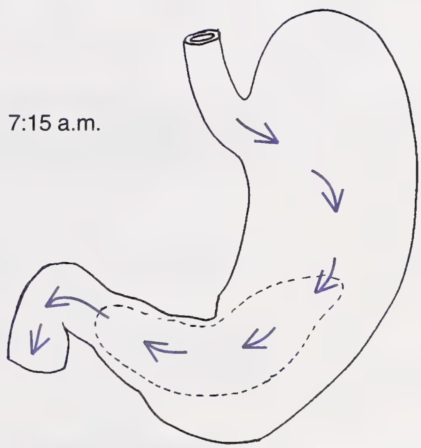
____

5. What is the function of the stomach?

____

____

Breaking Up Protein Molecules



Your stomach contains a strong acid, hydrochloric acid (HCl), and pepsin, an enzyme. The function of stomach acid is to start the breakdown of molecules of food that are made of protein. Other digestive juices will eventually complete the process in the stomach and intestines.

Have you ever had heartburn or excess acid in your stomach?

6. What are some of the usual causes of heartburn?

What household products do you use for relief of stomachaches? Many stomach remedies contain a weak base which neutralizes stomach acid. They are specifically designed to cure particular stomach problems, not necessarily the problem you may have. For example, you might be attempting to resolve excess stomach acid when in fact you could have food poisoning. If your stomachache feels different from the usual symptoms or if the problem persists, you should consult your physician.

7. Why is a stomachache difficult to diagnose?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Investigation: Breaking Up Protein Molecules

In this investigation you will use flavoured jelly powder which contains gelatin, a protein derived from animals, to examine how an enzyme breaks down a protein.

Materials You Need

- small bowl
- flavoured or unflavoured gelatin powder
- hot water
- MSG (monosodium glutamate) or meat tenderizer

Steps to Follow

STEP A

Make the gelatin mixture as directed on the box. Let it set.

STEP B

Transfer a portion of the jelly into another container. Sprinkle some meat tenderizer on the portion of gelatin.

OBSERVATION

Wait 5 to 10 minutes and then observe what happens.

8. Describe what happened to the gelatin.

____

____

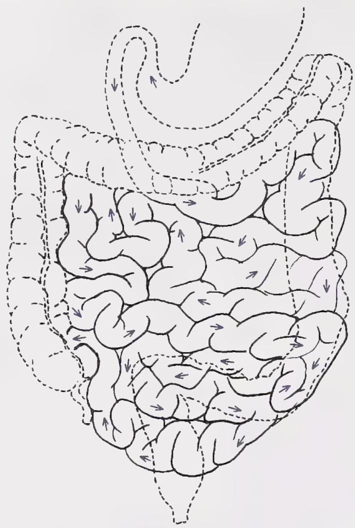
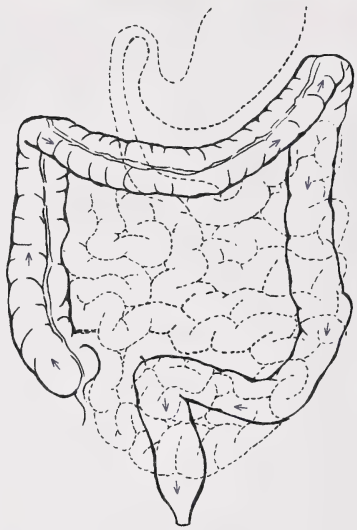
Observations

9. What happened to the large protein molecules in the gelatin?

____

____

Check your answers by turning to the Appendix, Section 1: Activity 2.

Digestion Stages	
Breaking Up Fat Molecules	**The Final Stage of Digestion**
	
12 noon to 3 p.m.	24 hours later

Your stomach releases the partly digested food to the small intestine. Bile, a fluid released by the liver, breaks the large fat particles into small pieces so the enzymes in the small intestine can digest the fat in foods.

10. If bile is produced by the liver, why does it sometimes give you a bitter unpleasant taste when you belch?

____

____

The small intestine carries out the final stage of digestion. The food is now in a form that can be absorbed through the intestine wall. It is carried by your blood to every cell in your body.

11. What is the function of bacteria in your intestines?

____

____

12. What are two functions of the large intestine?

The undigestible food bulk from the small intestines that your body cannot use passes into the large intestine. Water is absorbed and the remaining solid waste is then eliminated from your body.

13. Trace the path of a grilled cheese sandwich through your digestive system by describing the body systems responsible for converting the food into energy.

Check your answers by turning to the Appendix, Section 1: Activity 2.

After the food is digested and broken down into simpler forms, it can be transferred by the blood to all cells in the body. In the next activity you will study the process by which this simpler food is transferred into usable energy.

Activity 3: Respiration: The Fire in Your Body Cells

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How does your body use energy? How do you increase or decrease the amount of energy your body uses with various forms of activities? The energy from the foods you eat enables you to run, move, think, and do other body functions.

1. What activities did you participate in today that required energy?

____

____

2. What life processes require energy by your body right now?

____

____

3. How can you tell when your body requires energy?

____

____

Check your answers by turning to the Appendix, Section 1: Activity 3.

Investigation: Your Body Uses Energy

In this investigation you should discover the relationship between increased activity and an increased pulse and breathing rate.

Materials You Need

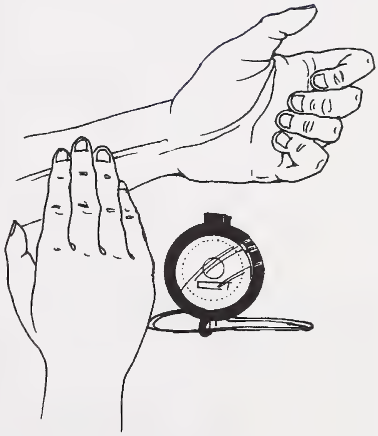
- stop watch or clock with a second hand
- place to jog

Steps to Follow

STEP A

Obtain your resting pulse rate, as shown on the right, by counting the number of beats in 10 s.

Multiply this number by 6 to find the number of beats per minute. For example, if you count 9 beats in the 10 s span, there are ($9 \times 6 =$) 54 beats per minute. (This method can be utilized for breathing rates as well.) Record your resting pulse rate in the observation table.



STEP B

Jog on the spot for 1 min while being timed.

Find your pulse and breathing rates per minute.

Record your findings in the observation table.

Jog on the spot for 1 min

Observations

4. Record your results in the observation table.

Rate	Before jogging	After jogging
pulse rate (beats per minute)		
breathing rate (breaths per minute)		

5. Use the data from the observation table to answer these questions.

   a. How did jogging affect your breathing?

   ____

   ____

   b. How did jogging affect your heart rate (pulse)?

   ____

   ____

   c. Did you notice any changes in your legs? What did they feel like?

   ____

   ____

Conclusions

Jogging increased the rate at which your body used energy stored in your muscles.

6. Which of these activities burns energy faster? Why?

   a. being sick or being healthy

   ____

   ____

b. sitting or standing

____

____

Check your answers by turning to the Appendix, Section 1: Activity 3.

How is energy released from food inside each cell in your body? Body cells must have a constant supply of energy in order for them to do whatever they do. Scientists have determined that the simple glucose molecule is the source for cell energy.

The transfer of chemical energy from food takes place in your muscle cells. The event that releases this energy to power your cells to move, grow, and carry out their functions is called **respiration**.

respiration – a process in which animals release energy, carbon dioxide, and water by reacting carbohydrates and oxygen in body cells

Even if you had microscopic vision you would not be able to see the molecules of food burning in your body cells to provide your body with all its energy requirements.

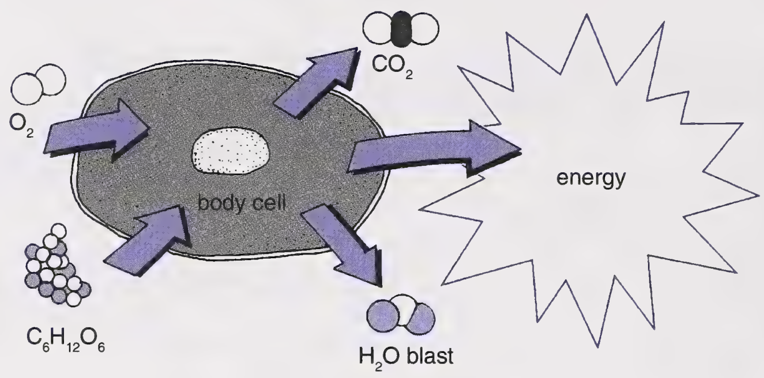
WESTFILE INC.

7. In what way is the release of energy from food in your muscle cells similar to the burning of fuel in a car?

____

____

Fire in Body Cells

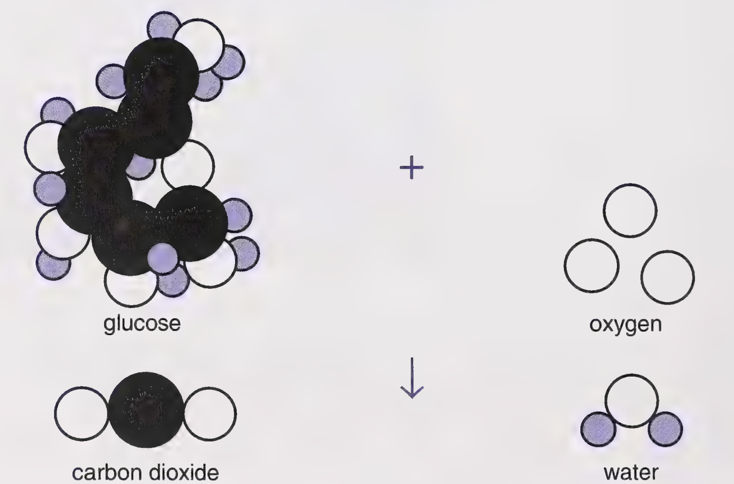


The process of respiration is the fire in your body's furnace. Like a fire which needs oxygen to burn, cell respiration also needs oxygen. Respiration occurs in all the body's cells.

Oxygen must enter the cell with digested food which is now in the form of glucose. The cell splits the glucose molecule apart to form carbon dioxide and water and to release **energy**. Glucose is moved by the blood system to every body cell. Adenosine triphosphate (ATP), a substance found in body cells, absorbs, transfers, and releases energy from food.

The following diagram illustrates the process of respiration by showing the molecules involved.

The Process of Cell Respiration



8. Write the process of respiration as a chemical word equation by using the given names for the chemicals involved. Show the reactants used and the products that are formed.

9. In what two ways is the process of photosynthesis different from the process of respiration?

Respiration is the opposite process of photosynthesis. In photosynthesis, carbon dioxide and water combine to form glucose and oxygen in plants. During respiration, glucose and oxygen break down or burn in body cells to produce carbon dioxide and water. Since photosynthesis absorbs energy, respiration releases energy.

10. How does your body get the oxygen for respiration?

11. What body needs are supplied by the breathing process?

12. Why do you breathe at a faster rate during exercise?

13. Why does your heart beat faster when you exercise more vigorously?

____

____

14. When is your breathing at its slowest rate? Why?

____

____

What Cures Fatigue?

15. How do you know when your body runs out of energy?

____

____

The foods that contain high levels of energy are mainly carbohydrates such as starch. These starches can then be broken down into glucose molecules, which are simple sugars.

Carbohydrates, such as pasta, are complex glucose molecules and therefore slowly release energy that the body requires.

On the other hand, simple sugars, such as those found in a chocolate bar, are burned in the body in a relatively short period of time.

16. Why would an athlete eat a spaghetti dinner instead of a chocolate bar to get the energy needed for competition?

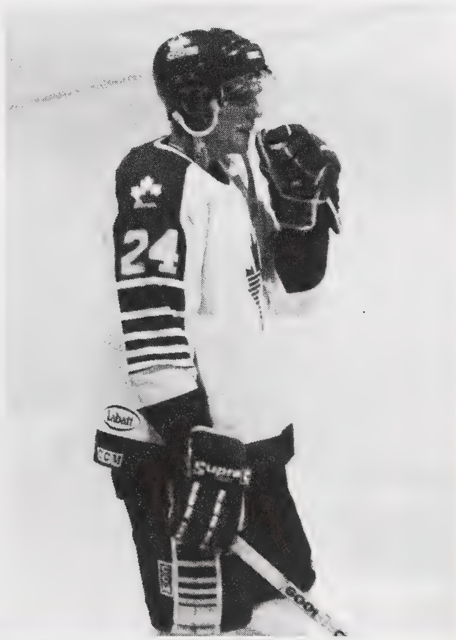
____

____

17. Why do some athletes eat a chocolate bar instead of a spaghetti dinner during competition?

____

____



Check your answers by turning to the Appendix, Section 1: Activity 3.

You have completed studying the final process involved in delivering energy to each cell – respiration. Since each food releases energy differently, how can you balance this release? In the next activity you will see how this can be achieved through a balanced diet.

Activity 4: What Is a Balanced Diet?

Did you have breakfast this morning? Does your lunch normally consist of fries and gravy, a can of pop, and a chocolate bar or doughnut? How often do you depend on fast foods or junk food? Have you ever been told that you are what you eat? What is a balanced diet?

The answers to these questions will become obvious when you evaluate diet choices. A well-balanced diet is based on the recommendations outlined in Canada's Food Guide.

1. What foods do you consider to be nutritious?

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2. Why would you consider the foods in the preceding diagram as an undesirable choice of foods in a balanced diet?

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A balanced diet consists of many types of food. An unbalanced diet has too much of one component, such as sugar.

nutrients – any substances, such as vitamins and minerals or ingredients, in food that nourish living things

A balanced diet will contain many **nutrients**. Fats, proteins, carbohydrates, vitamins, and minerals are all nutrients that your body requires. Fats are very high energy foods widely found in animal tissue or meat, milk and dairy products, vegetable oils, plant seeds, nuts, and some fruits.

3. List six plants that can be used as a source for vegetable cooking oil.

______________ ______________

______________ ______________

______________ ______________

4. List six foods that may be cooked using vegetable oil or animal fats.

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______________ ______________

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5. In some foods, the fat is not visible, it is hidden. What snack foods are known to contain hidden fats?

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6. If fat is such a high energy food, why do nutritionists generally recommend only a moderate dietary intake of fats?

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Proteins are the most abundant type of food and exist in many forms. They are needed for growth and the building of tissues, like skin and muscle. Proteins repair damaged cells and supply the body with molecules needed in many chemical reactions.

7. List four body parts that are largely dependent on protein for their structure.

______________ ______________

______________ ______________

Carbohydrates are the main energy source for your body. These include the sugars and starches which are common to many of the foods obtained from plant sources.

In addition to sugars and starches, carbohydrates also include cellulose (may be called fibre or roughage) such as wood or bran which is not digested by the body.

8. Identify each of the following foods as either fat, protein, or carbohydrate.

   a. corn ______________________

   b. cheese ______________________

   c. apple ______________________

   d. egg ______________________

   e. potato ______________________

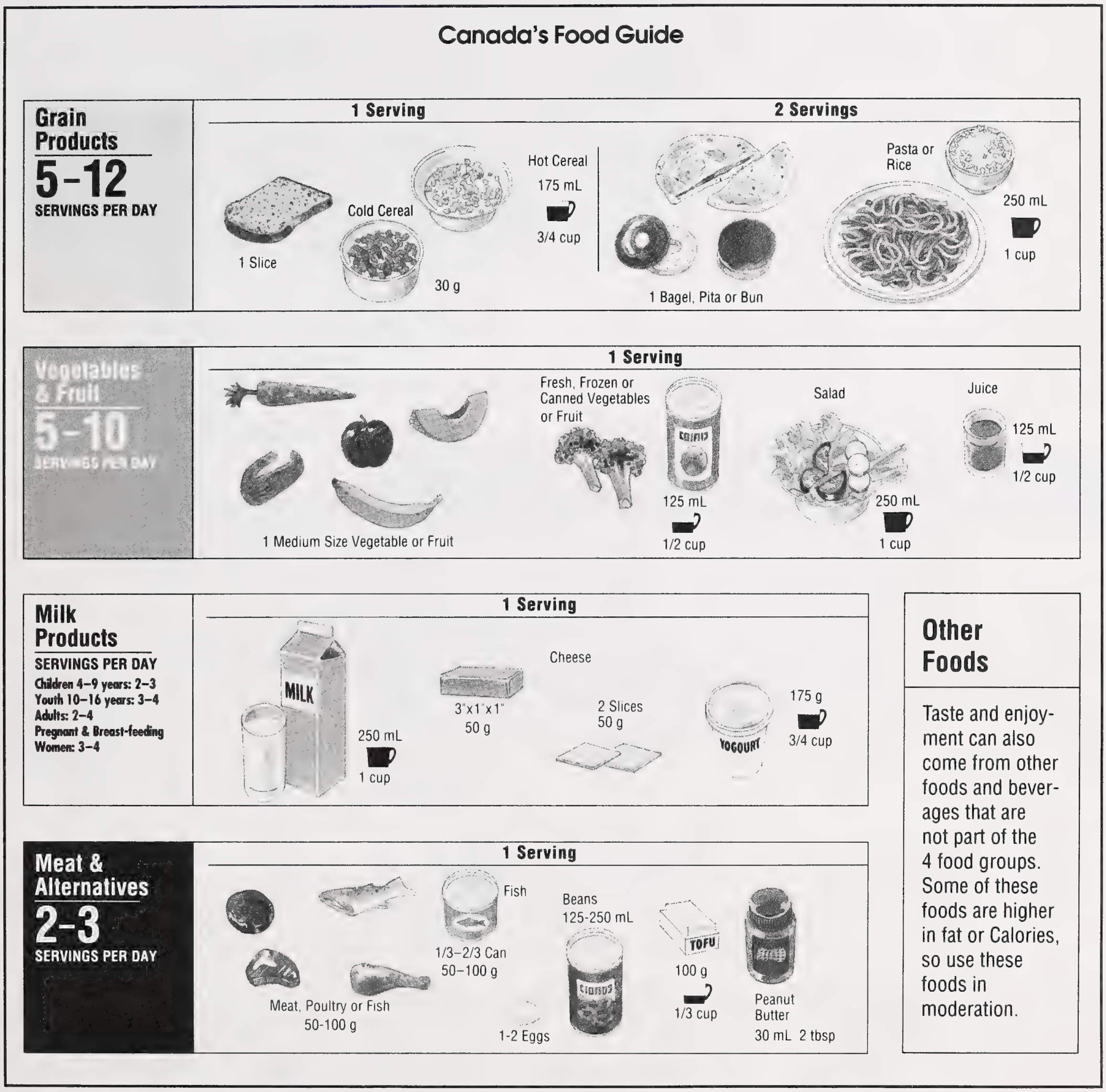
   f. chicken ______________________

   g. wheat cereal ______________________

   h. butter ______________________

   i. margarine ______________________

Canada's Food Guide tells you how much and what kind of food you should eat to have a balanced diet. The guide lists choices from the four main food groups for daily intake as shown in the graphic.



[1]

[1] Reproduced with the permission of the Minister of Supply and Services Canada 1992.

9. Refer to Canada's Food Guide to examine these two menus. Answer the questions that follow.

Menu A	Menu B
70 g hamburger 1 hamburger bun 1 slice cheese 20 pieces potato fries 1 cola 1 chocolate bar	85 g roast beef 1 medium baked potato 125 mL cooked carrots 125 mL cooked broccoli 60 mL white sauce 1 large bun (whole wheat) 1 wedge apple pie 1 glass whole milk

a. What essential foods for a balanced diet are missing from Menu A?

____

____

b. Identify which menu contains more vitamins and minerals.

____

c. Plan a menu for your dinner this evening. Be sure to note how much of each item you plan to eat. Do not forget beverages and condiments.

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10. Why are milk products recommended by Canada's Food Guide?

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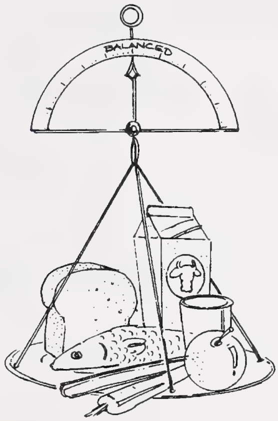
When you eat foods from all food groups, you supply your body with all the necessary vitamins, minerals, fats, proteins, and carbohydrates. This is called a balanced diet.



Check your answers by turning to the Appendix, Section 1: Activity 4.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Plants change light energy from the sun into chemical energy that is stored in plant leaves, stems, roots, and seeds. Animals, including humans, eat the plants to obtain energy. Energy is released during the process of respiration. Before respiration can occur in cells, digestion must occur.

Do either Part A or Part B. Part A involves an investigation, and Part B involves watching two videos. After completing either part, do questions 1 to 5.

Part A

Investigation: Graphic Representation of Digestion

In this investigation you should discover that food is broken down by digestion before it can be used by cells.

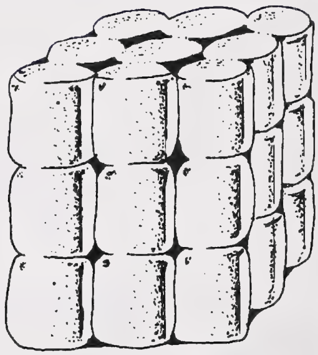
Materials You Need

- miniature marshmallows (coloured ones, if possible)
- toothpicks
- cooking pot

Steps to Follow

STEP A

Use the marshmallows and toothpicks to build a solid shape similar to the shape on the right. This shape represents a portion of food and its individual molecules.

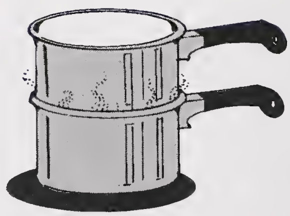


Solid shape

STEP B

Take your shape apart to represent how the molecules break apart during digestion.

Heat the marshmallows in a double boiler. This represents digested food.



Caution: Obtain instructions for using a double boiler if you have never used one.

Part B

Watch these two videos available from ACCESS Network:

- *Human Digestion*
- *Human Respiration*

You should discover that food is broken down by digestion before it can be used by cells.

Observation

1. What happens to solid food particles as digestion begins?

____

____

Conclusion

2. In what way are melted marshmallows similar to the original marshmallows?

____

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3. In what way are melted marshmallows different from the original marshmallows?

____

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4. In what way is digested food different from the original food?

____

____

5. Explain what has happened after food is digested and before the food energy can become body energy?

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Now answer the following questions.

6. Energy is changed before it can be used by your cells. Fill in the missing step in this path of energy movement.

   sun → corn → ________________ → human

7. Draw a diagram of a cell during respiration. Label the inputs – oxygen and glucose. Label the outputs – energy, water, and carbon dioxide.

8. Suppose a teenager eats the following foods in one day:

   - 1 cheeseburger
   - 2 glasses orange juice
   - 2 bags potato chips
   - 2 pieces of white bread with jam
   - 1 chocolate bar

   a. What foods could you add for balancing this diet? (Hint: Refer back to Canada's Food Guide.)

   ___

   ___

   ___

   b. What foods would you take away for balancing this diet?

   ___

   ___

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

Do **one** of the following.

1. Use library research to write a report on **one** of the following:

   a. the function of the pancreas and liver in the digestive process

   b. the function of enzymes in digestion

Manufacturers are required to state the ingredients in the food products that they sell. The label may tell the consumer how much energy and which nutrients are in a single food portion or the ingredient that is present in the largest amount by weight. But labels can be tricky. Sugar is listed in many different forms or names such as sugar, dextrose, sucrose, lactose, maltose, fructose, corn syrup, invert sugar, molasses, maple syrup, honey, etc.

2. Examine the labels of five grocery items such as crackers, sauces, etc. and list the names for the sugar found in the food item.

Ingredients are listed by weight with the largest amount first. Lesser amounts of the other ingredients are listed next. Food nutrients in terms of energy, protein, vitamins, and minerals may also be listed.

3. Locate the food contents of three different breakfast cereals.

    a. Use the information given on the cereal box to fill in the information in the chart.

Brand Name	Brand A:	Brand B:	Brand C:
Serving Size			
Main Ingredients			
Energy Total			
Protein Total			
Carbohydrates Total			
Fat Total			
Sodium Total			
Vitamin Total			
Iron Total			

b. What is the main ingredient in Brand B?

c. How large is the serving size for Brand A?

d. Which cereal has the most energy?

e. Which cereal has the most nutrients besides sugar or starch?

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

In this section you have studied several processes of energy transformations. Energy in sunlight is converted to food energy in plants by the process of photosynthesis. This food energy is delivered to the cells of your body through the process of digestion and is released to fuel all the activities and processes in your body through the process of respiration. The release of this energy to the cells can be controlled by diet. A balanced diet follows the portions and the kinds of foods that are essential for a healthy body as recommended by Canada's Food Guide. Since all these processes begin with sunlight, you can see that you are really solar-powered.

Assignment Booklet

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Section

2 Measuring Energy

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Is energy displayed in this photo? Your initial reaction might be to say no. However, energy is displayed in this photo, and more than one type of energy is displayed.

Energy can exist in many different forms. Energy can be mechanical, electrical, chemical, kinetic, or potential, as well as many other forms.

How can different kinds of energy be measured using some defined unit? Do different types of energies have different units of measurement? The answer is no. Besides a few conversion factors, all energy can be measured using the defined unit called a joule.

In this section you will evaluate the measurement of food energy and other energy forms in units known as joules. You will also examine and construct a calorimeter used to measure food energy. As well, the devices and techniques used to measure electrical energy will be considered.

Activity 1: What Are Joules?

Recall that work is done whenever a push or a pull called a force moves through a distance in the direction of the force. Energy is the capacity for doing work.

1. Explain how Dmitri does work when he eats spaghetti with a fork.

2. Explain why Shannon does not do any work as defined when she spends five exhausting hours intensively studying for a mid-term.

3. If Habib irons his shirt and pants, is work being done? Explain.

4. David, Holly, and their dad spent an entire day and a great deal of energy trying to move a huge stone found in the middle of the family farm field. If they were unsuccessful but were exhausted from their efforts, was any work done? Explain.

When work was done in the given examples, energy was required for a force to be exerted through a distance. The energy required for doing the work can be measured in **joules** (J). A joule of energy can be stated as the following:

joule – work done when a force of one newton (N) moves through a distance of one meter in the direction of the force

> 1 joule (J) of energy equals 1 joule (J) of work done when a force of 1 newton (N) moves through a distance of 1 metre in the direction of the force.

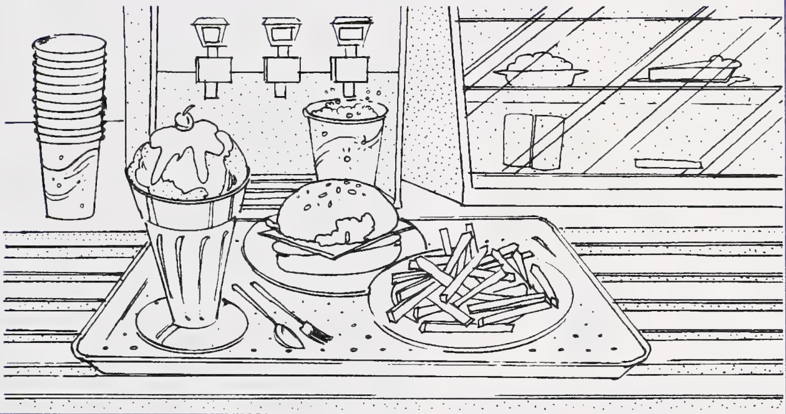
SI unit – any standard or derived units that are a part of the Systéme International d'unites from which all scientific measurements are made

The equivalent of 1000 joules is 1 kilojoule. The accepted International System or **SI unit** notation for the joule is J. The prefix kilo is *k*, therefore kilojoule is abbreviated as kJ.

$$1000 \text{ J} = 1 \text{ kJ}$$

What is a newton and how big is it? You would need 9.8 N of force to lift a 1 kg mass. 1 N of force is equal to about the weight of 18 pencils. An 8.18 kg turkey would exert a force of 80 N, and a person weighing 61.4 kg would exert a 600 N force.

Hidden Joules on a Tray



Scientists also measure the chemical energy in foods in units called joules.

Have you ever wondered how much energy you get from a cheeseburger and fries or a pizza obtained at a fast food outlet? How does this energy compare to that of a large ice cream cone, milkshake, or sundae obtained at a dairy bar? A cheeseburger has about 1300 kJ of energy while a large ice cream cone has about 1530 kJ of chemical energy.

Did You Know?

The energy required to climb 25 floors of stairs could come from just one peanut.

A school cafeteria offered the following menu for lunch without stating the energy values. This menu will be used to answer the questions that follow. You will find a more complete list of food contents with energy values in the Appendix.

Type of Food	Serving Size	Amount of Energy in Kilojoules
ketchup	15 mL	250
cheeseburger	1	1280
fried chicken	2 pieces	2500
french fries	20 pieces	920
french fries with gravy	20 pieces	2435
soda pop	1 can	460
vanilla milkshake	1	1200
brownies	1	400

5. Use the information in the preceding menu to determine how many kilojoules of energy you would obtain from eating the following meal.

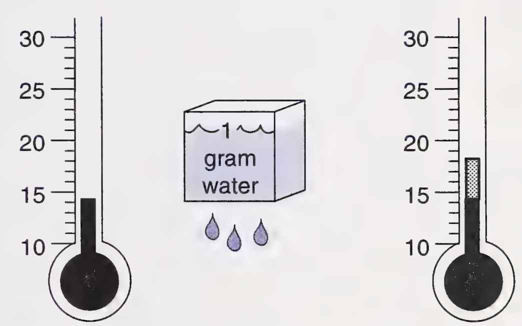
	Amount of energy
1 cheeseburger	________________ kJ
15 mL ketchup	________________ kJ
20 french fries	________________ kJ
1 vanilla milkshake	________________ kJ
Total kilojoules =	________________ kJ

6. Eating french fries with gravy would add ________________ kilojoules to your meal.

calorie – the amount of heat needed to raise 1 g of water 1°C

At one time, a **calorie** was the accepted unit of energy. It was defined as the amount of heat energy needed to raise 1 g (equal to 1 mL) of water 1°C.

Because joules are now the accepted standard, you would need to heat 4.2 g of water 1°C or 1 g of water 4.2°C to obtain equivalent amounts of heat.



You still find a reference to calories in some publications. You can convert calories to joules (J) by using the conversion: 1 cal = 4.2 J. In other words, you multiply the quantity of calories by 4.2 to get the equivalent amount in joules. Similarly, kilocalories (Calories) can be converted to kilojoules (kJ) by using the conversion: 1 Cal = 4.2 kJ.

7. Use the energy amounts from the cafeteria menu to calculate calories in the following. (Hint: Divide the number of kilojoules by 0.0042.)

   a. The number of calories in a cheeseburger is

   b. The number of calories in a vanilla milkshake is

   c. What problem do you recognize with these calculations?

   ____

   ____

   ____

At one time most food energy was commonly expressed in kilocalories or Calories. Note the use of a capital *C*. There were 1000 small calories in one large Calorie.

8. Use the calculated energy from the previous question to calculate the energy in Calories. (Hint: Divide calories by 1000 to obtain Calories.)

   a. The number of Calories in a cheeseburger is

   b. The number of kilocalories in a vanilla milkshake is (Remember: 1 Calorie = 1 kilocalorie)

9. If a deluxe hamburger has 2520 kilojoules, how many Calories does it have?

10. Calculate the number of Calories in a meal consisting of two pieces of fried chicken, fries and gravy, and a soda pop.

Check your answers by turning to the Appendix, Section 2: Activity 1.

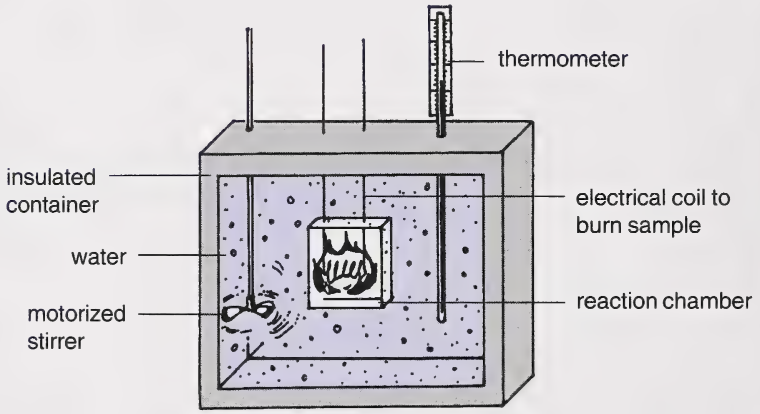
Activity 2: Here Comes the Calorimeter

Have you or someone you know ever declined a tempting dessert or pastry because it was high in Calories? Have you ever referred to a food table that listed food energy in Calories or kilojoules much like the one in the Appendix?

calorimeter – a device or container that uses temperature changes in water from which heat energy can be calculated

In the previous activity you learned that different foods have different amounts of energy. The energy in foods is measured using expensive but accurate bomb **calorimeters** not found in most school laboratories. A simplified diagram showing a bomb calorimeter is illustrated in the following diagram.

Bomb Calorimeter



Heat energy is released when the food is burned inside a reaction chamber located above or inside the bomb calorimeter. A specific mass of water surrounding the reaction chamber undergoes a change in temperature when it absorbs the energy.

Measurements are then taken and calculations are made based on the law of conservation of energy which states that energy cannot be created nor destroyed but can be transferred from one substance to another. This can be simply expressed by the following statement.

Heat lost by one substance = Heat gained by the other substance

1. Why is the water container in a bomb calorimeter well-insulated?

2. Why is the temperature of the water inside a bomb calorimeter measured before and after a food sample is burned inside the reaction chamber?

3. Why is the energy absorbed by the water inside a bomb calorimeter equal to the energy released by a food sample burned inside the reaction chamber?

4. If the initial temperature of water is 22.0°C and the final temperature of water is 31.2°C, what is the temperature change (Δt)?

Check your answers by turning to the Appendix, Section 2: Activity 2.

You can calculate how many kilojoules of energy there are in a substance if you do the following:

- Assume that heat lost (by burning substance) is equal to heat gain (by surrounding water).
- Assume that 1 mL of H_2O (water) is 1 g of H_2O.
- Know that the amount of heat energy depends on three factors:

  – the mass of the substance (in g)
  – the temperature change (in °C)
  – the specific heat of the substance (in J/g°C)

  Written in equation form the calculation looks like the following:

  Heat = $m\Delta tc$

  $$\text{Heat} = \underset{(\text{g})}{\text{mass of substance}} \times \underset{(^\circ\text{C})}{\text{temperature change}} \times \underset{(\text{J/g}^\circ\text{C})}{\text{specific heat of substance}}$$

> Example Problem
>
> Calculate the amount of heat energy, in joules and calories, released by a burning substance which causes 10 mL of water to rise from room temperature (25°C) to 37°C.
>
> There are 10 grams of water and the rise in temperature is 12 Celcius degrees; therefore heat energy = $m\Delta ct$
> = 10 g × 12°C × 4.2 J/g°C
> = 504 J
> = 0.504 kJ
>
> The amount of heat energy is 504 joules. Since 4.2 joules = 1 calorie, 504 joules = 120 calories.

Calculate the following energy changes.

5. The combustion of a marshmallow sample in a bomb calorimeter causes 1.00 kg of water to rise from 22.10°C to 24.60°C. Calculate the heat produced by this reaction.

6. A meat sample is burned in a bomb calorimeter. It causes 1.00 kg of water to rise from 25.20°C to 28.80°C. Calculate the heat produced by this reaction.

Check you answers by turning to the Appendix, Section 2: Activity 2.

You could construct a simple calorimeter by using nested polystyrene cups, water, and a thermometer as illustrated in the following diagram.

Simple Calorimeter

7. Why is polystyrene a suitable material for constructing a simple calorimeter?

8. What is the purpose in using the bottom cup?

9. The upper cup is usually filled with 100 mL of water.

   a. What is the purpose of the water?

   b. Why is this amount used?

10. What limitations would you encounter in using a simple calorimeter such as this one to determine the energy of a food sample?

Check your answers by turning to the Appendix, Section 2: Activity 2.

Investigation: Using a Constructed Calorimeter

In this investigation you will learn how a calorimeter works. Your calorimeter will produce an approximate value only for the heat given off from burning a food sample. The reason a simple calorimeter gives only an approximate value is that some of the heat that should be measured gets lost to the surroundings.

Scientists use sophisticated bomb calorimeters for accurate measurements. Your calorimeter will result in a fairly large experimental error, but the investigation is based on similar techniques used by scientists. The method is the same.

Caution: This investigation should be done outdoors or in a safe, well-ventilated location or fume hood. The black particles of carbon that are produced will soil hands and clothing. Do **not** do this in the kitchen.

Materials You Need

- 20 cm aluminum pie plate
- thermometer
- 2 pieces #18 wire, 3-5 cm long, or straight paper clip wire
- 2 bricks or a ring stand and ring
- 150 mL cool water
- metric measuring cup or 100 mL graduated cylinder
- food samples such as a shelled peanut, popcorn, dry cat or dog food, crouton
- matches

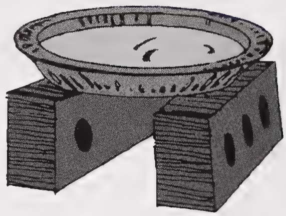
Steps to Follow

STEP A

Set up the apparatus for the calorimeter as shown on the right. The apparatus must be set up on a fireproof surface.

Separate the two bricks so that the wire containing the sample may be inserted.

Place the pie plate on the two bricks.



STEP B

Measure 150 mL of water using a measuring cup or the graduated cylinder.

Pour the 150 mL of water into the pie plate.

STEP C

Place a thermometer into the water to record all temperature changes. (Make sure the thermometer does not rest on the bottom of the plate.)

Record the water temperature in the observations table before burning the sample.

STEP D

Weigh your food sample. Record the weight in the observations table.

STEP E

Bend a piece of wire so that it is able to hold a food sample on it.

Place the food sample on the wire and put it underneath the pie plate. Make sure that the distance between the food sample and the pie plate is approximately 2 cm.

STEP F

Ignite the food sample on the wire, making sure that the sample totally burns to ashes.

In the observations table record the temperature of the water after the food completely burns.

STEP G

Calculate the temperature change of the water by subtracting the initial temperature from the final temperature.

Record this temperature change in the table.

STEP H

Repeat steps D - G for the other required food samples. Clean the plate after investigating each sample.

Observations

Type of food or substance and weight	Temperature of water before burning (°C)	Temperature of water after burning (°C)	Change in temperature of water (°C)
peanut ________ g			
popcorn ________ g			
dry cat or dog food ________ g			
other ________ g			

Conclusions

11. Use the data obtained in the observations table to calculate the amount of energy in the samples:

a. the peanut

b. the popcorn

c. the dry cat or dog food

d. other

12. Which food had the most energy?

____

13. The peanut has a high fat content. Did it release more or less energy than the popcorn which is a carbohydrate?

____

14. If the accepted energy content for any of the substances used in this investigation were listed in the Appendix, it is likely that there would be a large discrepency between the actual values and the ones that you observed in the investigation. What reasons would account for this?

____

____

____

____

15. Explain how heat energy stored in various foods can be measured.

____

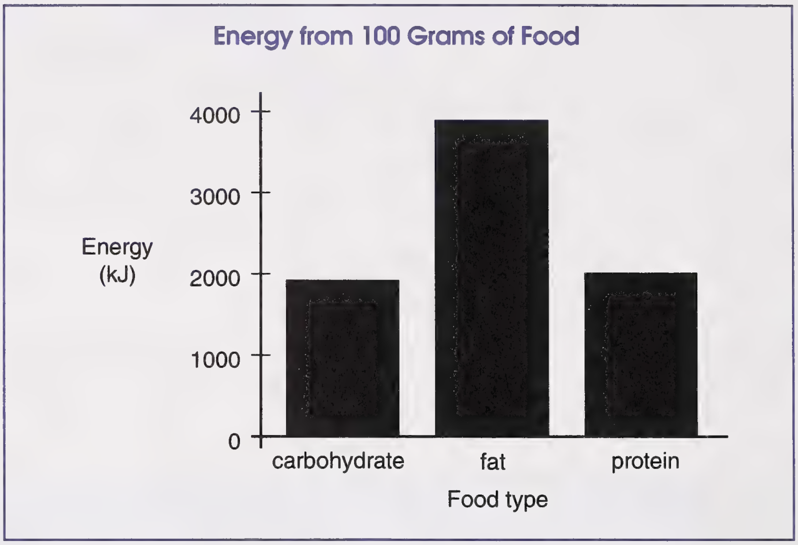
____

____

____

Check your answers by turning to the Appendix, Section 2: Activity 2.

When food is burned it gives off heat. This energy can be measured using a calorimeter. Measurements show that different food groups contain different amounts of energy. The data obtained from an experiment using a bomb calorimeter is shown by the graph in the following figure.



16. What amount of energy would you expect to obtain from a carbohydrate compared to an equal amount of fat?

____

____

control variable – a factor in an experiment that is kept constant so that it does not affect the outcome of the results from one trial to another

17. What was the **control variable** in the bomb calorimeter experiment?

____

____

manipulated variable – a factor in an experiment that can be altered to affect the outcome

18. What was the **manipulated variable** in the bomb calorimeter experiment?

____

____

responding variable – the factor in an experiment that is affected by the change in the manipulated variable

19. What was the **responding variable** in the bomb calorimeter experiment?

____

____

Check your answers by turning to the Appendix, Section 2: Activity 2.

Activity 3: Other Energy Forms

Besides food energy, what other energy sources were you dependent on today? For example, is electrical energy an important source of energy for your daily activities? Could you exist without electricity or imagine a lifestyle without it?

The law of conservation of energy states that energy cannot be created nor destroyed but may change from one form to another. Energy does not get used up, it merely changes. There are many different forms of energy that you will study in this activity.

1. When a speeding car is involved in a collision with a pole, what happens to the car's energy?

____

____

2. When a waterfall or running water produces electricity by turning an electric generator, what happens to the energy?

____

____

You have already studied a few forms of energy. The form of energy that is stored in the foods you eat is known as chemical energy. The energy stored in various fuels is also known as chemical energy.

3. When wood is burned in a fireplace, what happens to its chemical energy?

____

____

4. What happens to the chemical energy of gasoline when it burns in a car engine?

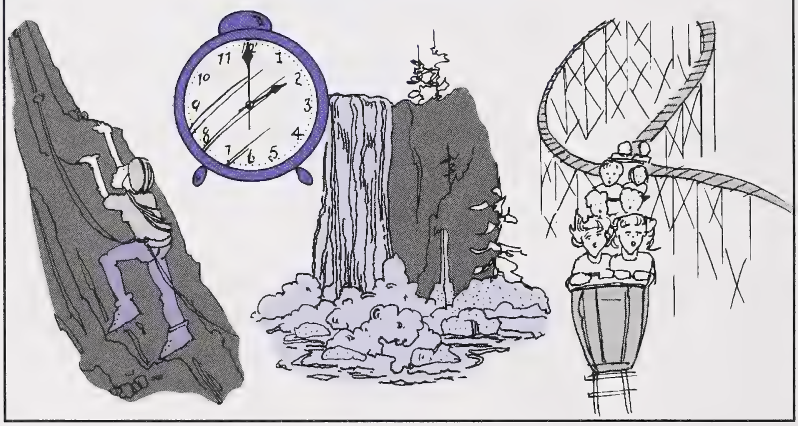
____

____

mechanical energy – energy of moving parts whether they actually move or are only capable of motion

The energy you need to do everyday tasks is known as **mechanical energy**. It is the energy of moving parts, whether it involves motion or is capable of producing motion, as illustrated in the following diagram. Mechanical energy is made up of kinetic energy and potential energy.

Mechanical Energy



kinetic energy – energy possessed by any moving object

Kinetic energy is the energy of movement, such as walking, or motion of such things as the wind or a flowing stream. **Potential energy** is stored energy found in such things as batteries, food, and fuel.

potential energy – a form of stored energy resulting from the position of an object that has the potential to be released

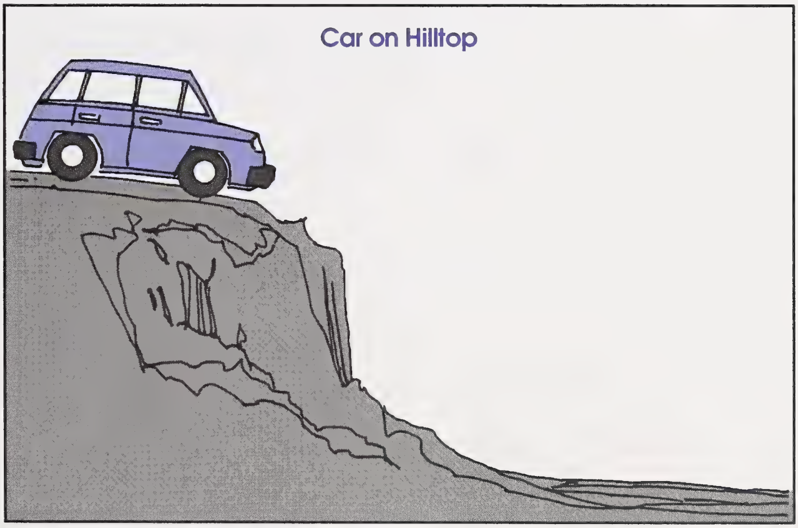
An object is also said to possess potential energy due to its position. A stretched rubber band or a rock that sits on the top of a hill has potential energy. When the rock rolls down the hill, its potential energy is changed to kinetic energy.

5. List four common examples where an object, due to its motion, is said to possess kinetic energy.

6. Why is a stretched rubber band considered to possess potential energy?

7. Suggest two common examples where an object, due to its position, is said to possess potential or stored energy.

The following diagram illustrates the position of a car on top of a hill. Use this information to answer the questions that follow.



8. Why does the car on the top of the hill exhibit potential energy?

9. Describe the energy changes involved as the car changes its position from the top of the hill to the bottom of the hill.

10. Classify the following examples as having potential or kinetic energy and state the reason why.

    a. a match inside a packet

    b. water running from a tap

    c. stretched elastic band

    d. a glass of milk

    e. a bird singing

    f. a new 9-volt alkaline battery

nuclear energy – energy released when the nucleus of an atom splits or combines with another

Do you recall where these energies originated from? The sun, as well as all the billions of other stars, go through a process that results in the formation of **nuclear energy**.

11. Where is nuclear energy produced on Earth and for what purpose?

____

____

You may be more familiar with the use of nuclear energy in nuclear weapons. Although this is a form of nuclear energy, it is not the only form. Nuclear energy is also used in medicine and in the production of electricity.

Nuclear energy from the sun is called solar energy. It travels to the Earth in many different forms. The visible light that you observe from the sun is one form of energy and heat energy is another.

thermal or **heat energy** – form of energy arising from motion of atoms or molecules

Thermal or **heat energy** is emitted when molecules begin to move rapidly. In other words, heat is the kinetic energy of molecules. Your calorimeter experiments allowed you to measure the chemical energy stored in various foods. The energy was observed as heat.

12. Give common examples where light energy is produced.

____

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____

____

13. Give common examples where heat energy is produced.

____

____

____

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Why Is Nuclear Energy a Threat?

14. Why is nuclear energy considered a threat by so many people?

____

____

15. How is nuclear energy beneficial?

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____

____

____

sound energy – energy produced by vibration of atoms or molecules

Another type of energy is **sound**. Your brain interprets vibrating air molecules originating from a source as sound. The moving molecules in a sound wave that come from your radio cause your eardrum to vibrate. Your brain then interprets this as sound.

16. Give examples that depend on sound energy.

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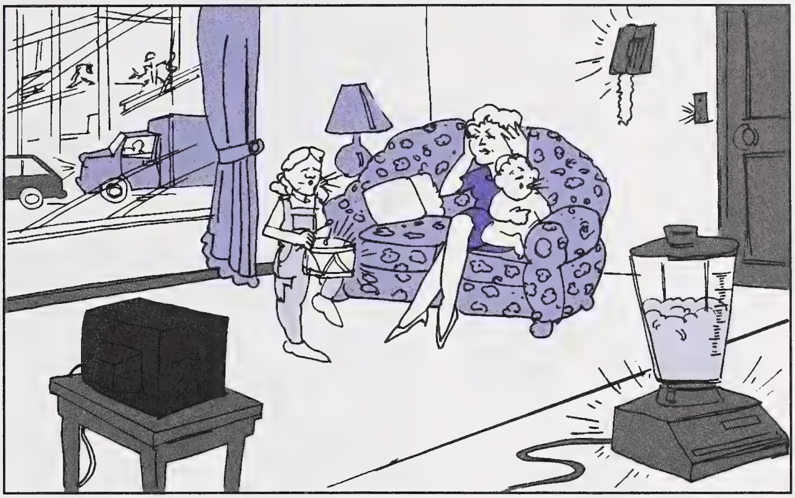


17. Name the sources of sound energy shown in the preceding diagram.

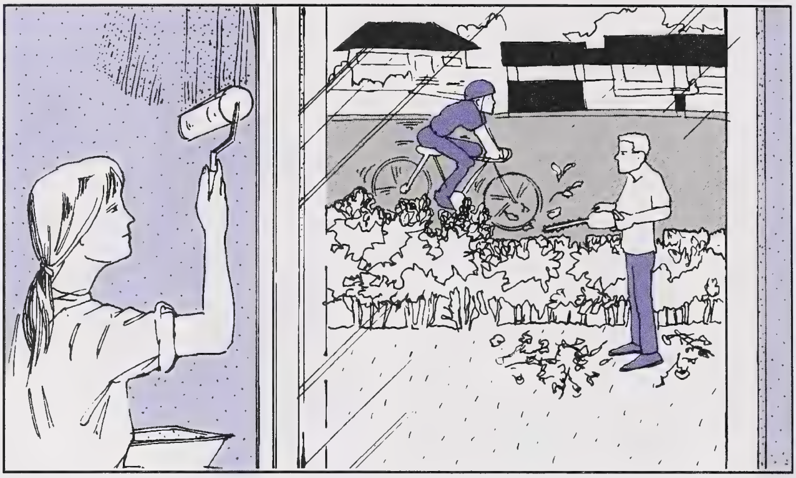
18. Is sound always beneficial? Explain.

electrical energy – energy resulting from movement of electrons through a substance

Electrical energy, the energy required for use in electrical devices, is one more type of energy. Electrical energy is carried by the movement of electrons inside a substance.

19. Give four common examples that depend on electrical energy.

Check you answers by turning to the Appendix, Section 2: Activity 3.



20. What type of energy is illustrated in the preceding diagram and where did people get their energy to do these jobs?

____

____

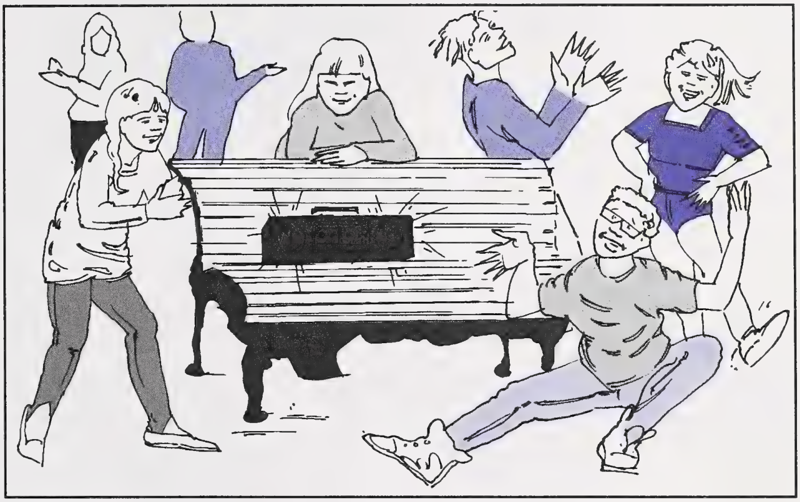
21. What type of energy powers something like a car or a lawnmower? Where does this energy come from?

____

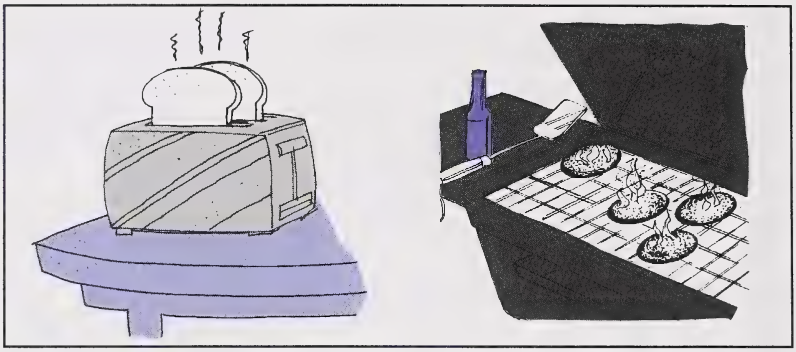
____

Quite often more than one form of energy is involved in an activity. Sometimes one type of energy will change into another.

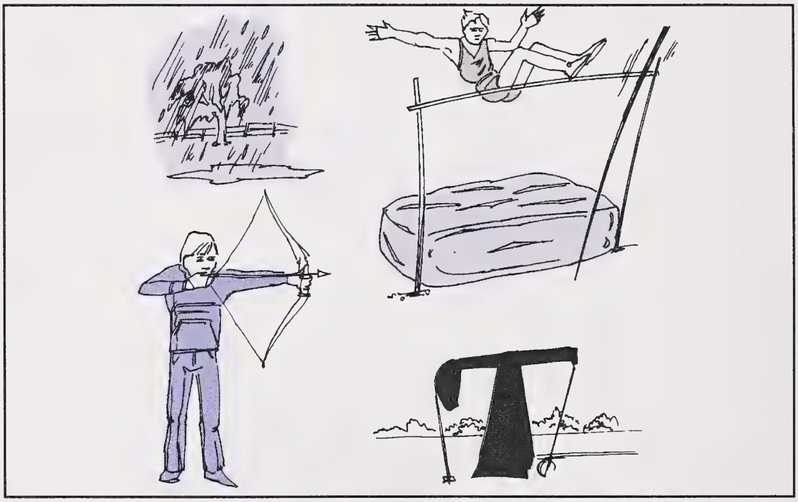
Recall that the law of conservation of energy states that energy cannot be created nor destroyed but it can be changed from one form to another to do work for you.



22. Identify six different forms of energy in the illustration and indicate how they are used.



23. What energy changes are involved when toast is made in a toaster or charcoal is burned in a grill?



24. What form of energy is represented by the examples in the preceding diagram? Why?

Check your answers by turning to the Appendix, Section 2: Activity 3.

25. Turn a radio on and listen to a station for one minute before answering the next questions.

    a. Describe the forms of energy that the radio represents.

    ____

    ____

    b. Describe what happens to your eardrum.

    ____

    ____

    c. Describe the forms of energy represented by this activity.

    ____

    ____

26. Describe the forms of energy involved when water behind a dam is released to operate a generator in a hydroelectric plant.

    ____

    ____

27. Describe the forms of energy involved when wind moves a sailboat across a lake.

    ____

    ____

28. Describe the forms of energy involved when a program is broadcast on television.

    ____

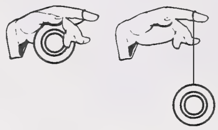
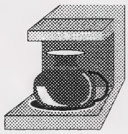
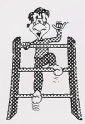
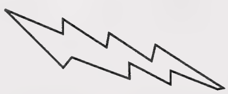
    ____

29. Describe the forms of energy involved when clouds are produced.

    ____

    ____

30. Fill in the table by identifying the original energy form and the form that it becomes.

Example	Original Energy Form	New Form of Energy
yo-yo 		
coffeemaker 		
telephone 		
climbing a ladder 		
lightning 		

Check your answers by turning to the Appendix, Section 2: Activity 3.

Activity 4: Measuring Other Energy Forms

How much electrical energy do you use per month for your activities, and how is it measured? The fuel gauge in your car estimates how many litres of gasoline are still in the fuel tank, but what device measures the energy consumed by your car? Natural gas is sold by the cubic metre but how is the natural gas energy that fuels your house furnace measured?

In this activity you will analyse how quantities of energy are measured.

Chemical and Heat Energy Measurement

The heat energy in natural gas and other fuels is measured in megajoules (MJ) which means one million joules (*mega* means million). The following table gives the number of kilojoules released when one kilogram of various fuels are burned. Refer to the table to answer the questions that follow.

Approximate Energy Equivalents of Fuels (in kJ/kg)			
Food Fuels		Heat and Transportation Fuels	
carbohydrates	17 000	natural gas	56 000
fats	38 000	propane	55 000
proteins	17 000	butane	49 000
		gasoline	48 000
		fuel oil	44 000
		coal	28 000
		wood	15 000

1. How could the energy equivalents in the preceding table be converted to megajoules?

____

____

2. Which fuel has the highest amount of heat energy per kilogram?

____

3. Which fuel has the least amount of heat energy per kilogram?

____

4. How much heat energy does fuel oil provide per kilogram compared to wood?

____

5. Use the given data to predict why propane is becoming more popular as a fuel for trucks and cars.

____

6. Explain how the amount of energy from the given fuels could be determined from calorimeter measurements.

____

____

____

____

Check your answers by turning to the Appendix, Section 2: Activity 4.

Radiant Energy Measurement

Why do people who live in tropical areas often wear white clothing? If you are outdoors on a sunny day, do you know why your body feels hot when you wear dark clothing or cool when you wear white clothing?

radiant energy – energy transferred by radiation such as heat or light

Radiant energy from the sun is absorbed by dark surfaces. Wearing dark clothes on a winter day will keep you warmer; white clothing reflects radiant energy, so wearing white in a sunny climate will help you keep cooler.

Investigation: Using Temperature to Measure Radiant Energy from the Sun (or Measuring Solar Energy)

In this investigation you are going to find the best way to trap the radiant energy from the sun.

Materials You Need

- 4 glasses or 4 100-mL beakers
- aluminum foil
- black paper
- scissors
- labels
- tape
- thermometer
- clock

Steps to Follow

STEP A

Label the four glasses (or beakers) as A, B, C, and D.

Leave Glass A as is and cover Glass B with aluminum foil.

Cover Glass C with black paper.

Cover one-half of Glass D with aluminum foil and the other half with black paper.

Glass A Glass B Glass C Glass D

STEP B

Put 50 mL of water in each glass and record the temperature of the water in each glass.

Record these temperatures in the observation table.

STEP C

Place the four glasses in direct sunlight making sure that the aluminum side of Glass D points away from the sunlight.

STEP D

Record the temperature of the water in each glass every 15 minutes.

Note: If no temperature changes result, do not use any water; just measure the air temperature inside the glasses.

Observation

Time in minutes	Temperature of water in degrees Celcius			
	Glass A	Glass B	Glass C	Glass D
0 min				
15 min				
30 min				
45 min				
60 min				

7. In which beaker or glass did the water get the hottest?

____

8. Where did the heat come from?

____

9. Why is more energy trapped by Glass D which has aluminum foil placed behind it?

____

Conclusions

10. From your observations in this investigation, what conclusion can you make about dark surfaces and surfaces such as aluminum?

11. Explain, in terms of heat absorption and reflection, why the temperature is much greater inside an automobile than outside on a hot summer day.

Check your answers by turning to the Appendix, Section 2: Activity 4.

Investigation: Using a Lens to Focus Light

In this investigation you are going to use a magnifying glass to focus sunlight.

Materials You Need

- magnifying glass
- dish or spoon
- thermometer
- 10 cm × 10 cm white paper
- 10 cm × 10 cm black paper
- watch

Caution: This should be done outdoors under supervision. Do **not** direct the focussed beam into anyone's eyes as the retina can be damaged.

Steps to Follow

STEP A

Record the starting temperature on your thermometer.

STEP B

Using the magnifying glass, focus sunlight to the smallest point on a nonflammable flat surface such as a dish or spoon for one minute.

STEP C

Place the thermometer on the point where sunlight was focussed by the magnifying glass.

Record the highest temperature reached on the thermometer.

STEP D

Using the magnifying glass, focus sunlight on a small piece of white paper until the paper begins to burn. Record the time it takes.

STEP E

Repeat Step D using a small piece of black paper.

Observation

Thermometer Reading	Temperature
Before exposure to sunlight	
After exposure to sunlight	

Paper	Time for Ignition
White paper	
Black paper	

Conclusion

12. Assuming that the rise in temperature per minute remains the same, how long would it take for the temperature to reach the boiling point of water (100°C)?

13. Why does black paper ignite faster than white paper?

14. Explain how bottles thrown out of a car window could start forest fires.

Check your answers by turning to the Appendix, Section 2: Activity 4.

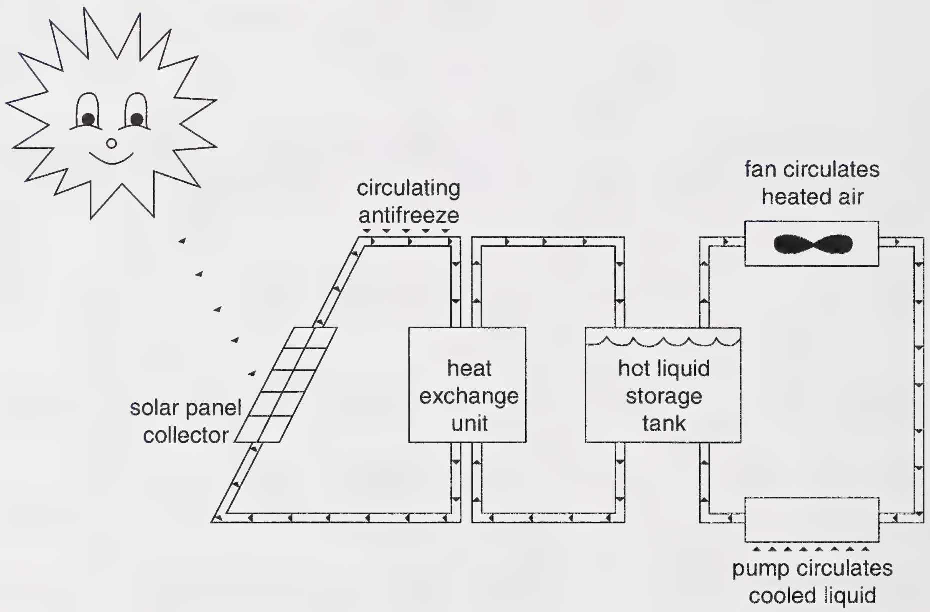
Have you ever seen or been inside a house heated by solar energy using solar collectors? Did you ever try to cook meat using only solar energy?

solar collector – device used to capture radiant energy from sunlight

All houses gather heat from radiant energy obtained from sunshine. However, some dwellings and ovens depend on special **solar collectors** for heating or cooking.

Collectors can vary from an arrangement of tilted windows to high technology panels and mechanical equipment which collect solar energy and transfer the energy for heating or cooking. The following diagram illustrates how solar energy can be gathered by a typical high technology collector panel and transferred by mechanical means to heat a dwelling.

How Collectors Transfer Energy



15. What two factors could determine the maximum amount of solar energy that can be gathered by a typical high technology collector panel?

____

____

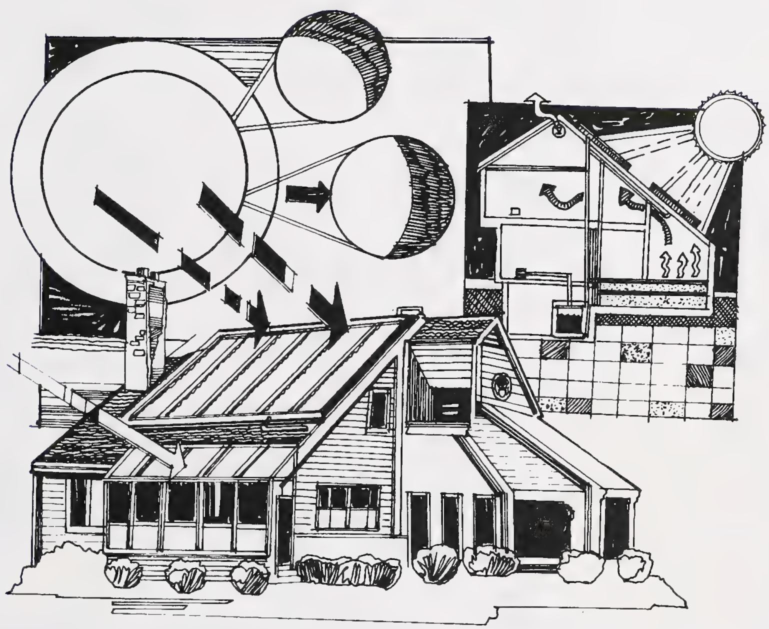
16. Buildings that rely on solar energy generally have a dark or black-coloured roof, mechanical equipment, and circulating pipes. Why?

____

____

A typical solar energy dependent dwelling is shown in the following graphic.

Solar Housing



17. How does the construction design of a solar dependent house differ from a conventional type of residence?

____

____

____

____

18. Besides the amount of sunshine, what other factors could limit the popularity of using solar energy for dwellings in northern Canadian climates?

19. Why are curved parabolic mirrors or shiny surfaces often used to design solar collector ovens and cooking devices? Where would these devices be most popular?

20. A bank of silicon solar cell collectors change solar energy directly into electricity. Where do you think these devices would be used?

Check your answers by turning to the Appendix, Section 2: Activity 4.

Sound Energy Measurements

frequency – the number of times an event occurs in a given interval of time, such as vibrations per second

The unit used for sound **frequencies** is a hertz (Hz), named after a German physicist. Humans can hear sounds vibrating at frequencies ranging from 16 Hz to 20 000 Hz.

Many animals have a greater range of hearing. Dogs are able to hear sounds up to 35 000 Hz. Cats can hear sounds up to 50 000 Hz.

Investigation: Sources of Sound Vibration

In this investigation you will create some sound vibrations.

Materials You Need

- elastic band
- tuning fork
- jar or glass of water
- plastic wrap
- small amount of sand or table salt

Steps to Follow

STEP A	OBSERVATION
Strike the tuning fork gently and then place it near your ear.	21. Describe what happened. ________________________ ________________________ ________________________ ________________________ ________________________ ________________________

STEP B	OBSERVATION
Strike the tuning fork gently and then touch the surface of a jar or glass of water.	22. Describe what happened. ________________________ ________________________ ________________________ ________________________ ________________________ ________________________

STEP C	OBSERVATION
Place a piece of plastic wrap across the top of the jar or glass. Sprinkle some sand or salt on the top of the plastic wrap. Strike the tuning fork and then place it on the plastic wrap.	23. Describe what happened.

Conclusion

24. Why would it be difficult for you to make measurements of the frequency or the vibrations per second created with a tuning fork in this investigation?

25. Does this mean that frequency measurements for this investigation cannot be made? Explain.

26. Suggest how frequency measurements for this investigation could be made.

Check your answers by turning to the Appendix, Section 2: Activity 4.

decibel – unit of relative loudness or difference in power between sound or electrical signals

The loudness of sound is measured in units called **decibels** (dB). The decibel scale starts at zero, the faintest sound detected by the human ear. The threshold of pain is rated at 120 dB, where sound can cause pain to your ears.

PHOTO SEARCH LTD.

27. Suggest why many musicians and many people who listen to amplified music could develop hearing problems.

____

____

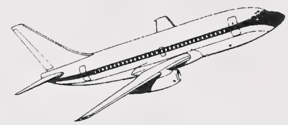
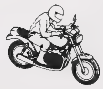
28. What precautions should people take when they work in a noisy environment such as a rocket launch or an area where a jackhammer or heavy machinery is used?

____

____

The approximate intensities of some common sounds are listed in the following table. Use the information from the table to answer the questions that follow.

Noise Level (decibels)

	– lethal level (180 dB)	jet plane takeoff (145 dB)
140	– eardrum damage	
130	– painfully loud	
120	– threshold of pain honking car	loud music (120 dB)
110	– threshold of discomfort shouting in ear	
100	– deafening circular power saw	accelerating motorcycle (104 dB)
90	smoke detector vacuum cleaner	
80	motors	
70		busy street traffic (70 dB)
	– ordinary conversation	
60		
50		
40	quiet radio	broadcasting studio (15 dB)
30	whispering	
20	– very faint	
10	– just audible human breathing	rustling leaves (10 dB)
0	– threshold of hearing	

29. Name three occupations where sound can cause damage to your ears.

30. Suggest three other sources of sound having a decibel rating above 120 dB.

31. Suggest three other sources of sound or environments having a decibel rating below 40 dB.

32. Predict the noise level or decibel reading in a classroom during an exam or library use. Explain what sounds you used in making your prediction.

33. Estimate the average noise level or decibel reading that you encounter on a daily basis and explain the reason for your answer.

Check your answers by turning to the Appendix, Section 2: Activity 4.

Electrical Energy Measurements

How much electrical energy do you depend on? Did you use an electric appliance recently? How can electrical energy be measured if you cannot see it?

watt – an SI unit of power equal to one joule per second

Light intensity or brightness is measured in lumens. Lamp efficiency is measured in lumens per watt. A **watt** is a unit for measuring the rate of electrical energy consumed, equal to one joule per second.

The lamp that gives the most lumens per watt, that is, the most brightness per energy consumed, is the most efficient lamp. An incandescent lamp has 8 to 25 lumens per watt. A fluorescent lamp has 33 to 77 lumens per watt. Sodium lamps, used for street lighting, have 45 to over 100 lumens per watt.

34. Why is the fluorescent lamp more efficient than an incandescent light bulb?

____

____

You can think of electricity as tiny bundles of electrical charge that flow through the wires of electrical devices such as light bulbs, toasters, hairdryers, or the coils in electric motors. These tiny bundles, called electrons, are small negative particles that are very mobile.

polarity – tendency of an object to have one of two separate and opposite characteristics

Since the **polarity** of electron particles is negative, gaining a significant number of electrons will result in a substance being negatively charged. If electrons are lost, negativity is lost.

Have you ever had someone come up to you after walking on a carpet and give you a shock? What happens is that as a person gains static electricity by walking on a carpet, there is a build up of a negative charge. When that person touches someone else, this negative charge is released in the form of a shock. The person now has a neutral charge which is neither positive nor negative.

35. Explain how a shock from static electricity is produced.

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____

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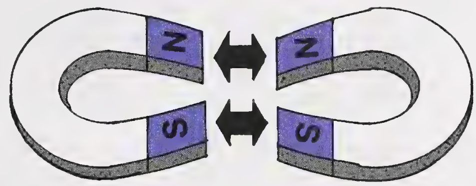
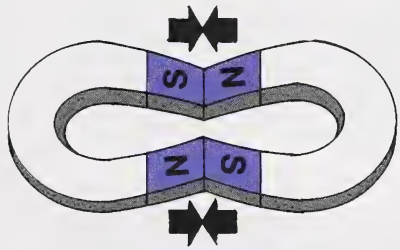
If you ever used magnets you probably know that magnets also have a polarity.



like charges repel



unlike charges attract

36. a. What magnet polarities will pull two magnets together?

____

____

b. What magnet polarities will push them apart?

____

____

With magnets, it is the opposite charges that are attracting. Likewise, the same charges repel each other.

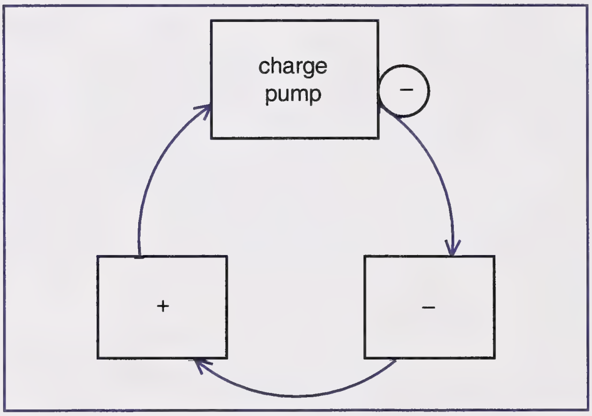
The same rule applies to electrical polarity as does to magnetism, but rather than calling the charges a north and south pole, they are referred to as negative or positive. A negatively charged particle is denoted by a minus sign (–) and a positively charged particle by a plus sign (+).

37. Use a check mark to summarize which charges attract and which charges repel each other in the following table.

Charges	Attract	Repel
+ −		
− −		
+ +		
− +		

electrical current – the number of electrons that flow through a wire per second

What does this have to do with **electrical current**? The flow of electrical current is from a negatively charged pole to a positively charged pole as illustrated in the following diagram.



For an electrical current to exist, a kind of charge pump, which produces negative charges, must be present. The charge pump that you are likely most familiar with is a battery. This charge pump, or battery, is the energy source involved in doing the work required to move electrons to the negative terminal.

The following graphic will explain several terms used when measuring electrical energy.

The number of electrons that flow through a wire per second is known as electrical ***current***.

The unit for electrical current is the ***ampere*** (A) named for the scientist that observed this phenomena.

The amount of energy each electron has is known as ***voltage*** (V) or $\text{voltage} = \dfrac{\text{energy}}{\text{charge}}$.

Power is a measure of the rate in which electrical energy is used or $\text{power} = \dfrac{\text{electrical energy}}{\text{time}}$.

Power can also be expressed as the product of the electrical current (A) and the voltage (V) or power = ampere × voltage.

The unit of measurement for power is the ***watt*** (W), also named after a scientist. One watt is equal to one joule per second or $1\ \text{W} = \dfrac{1\ \text{J}}{\text{s}}$.

The following chart summarizes the electrical energy measurements.

$$\text{voltage} = \frac{\text{energy}}{\text{charge}}$$

$$\text{power} = \frac{\text{electrical energy}}{\text{time}}$$

$$\text{energy} = \text{power} \times \text{time}$$

$$\text{power} = \text{ampere} \times \text{voltage}$$

$$1\ \text{W} = \frac{1\ \text{J}}{\text{s}}$$

electrical power – the rate at which electrical energy is consumed

Now, you should be able to measure electrical energy expressed in joules (J) by multiplying the **electrical power** in watts (W) by the amount of time (in seconds) for the electrical device used.

For example, you can find out how much energy a 1500-watt hairdryer uses in 30 seconds as follows:

$$\begin{aligned}\text{Energy} &= \text{power} \times \text{time}\\ &= 1500 \text{ watts} \times 30 \text{ seconds}\\ &= 1500 \text{ (joules/second)} \times 30 \text{ seconds}\\ &= 45\,000 \text{ joules}\\ &= 45 \text{ kilojoules}\end{aligned}$$

38. How much energy does a 100 watt light bulb use in 1 hour?
    (Hint: 1 hour = 3600 seconds)

____

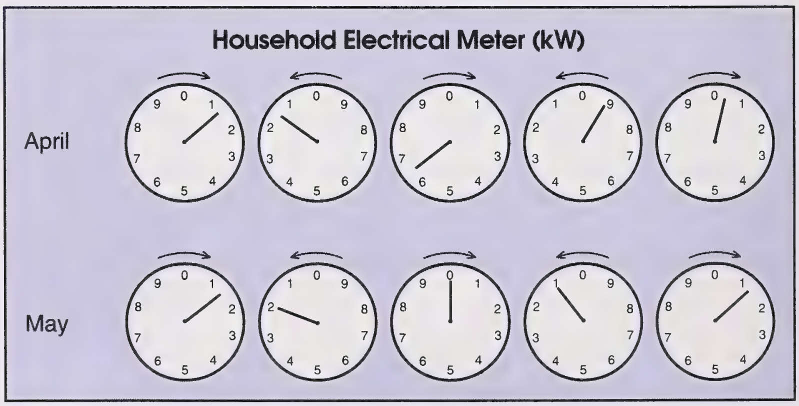
____

____

kilowatt-hour – unit of electric power used or the total energy developed by a power of one kilowatt acting for one hour

The readings for household consumption of electrical energy are expressed in units of **kilowatt-hours** (kW•h) instead of joules. They are related by the conversion factor of 1 kW•h = 3600 kJ. This only means that power is expressed in kilowatts (kW) and time in hours (h).

Your household meter, as illustrated in the following diagram, measures power consumption in kilowatts. The meter is read from left to right. If the dial is between two numbers the lower number is used in calculating power consumption.



39. What is the reading in kilowatts (kW) of the meter in May?

____

40. a. If the April reading in kilowatts was 11 690, how many kilowatt-hours of electrical power were used between April and May?

____

b. If the cost per kilowatt-hour is $0.17, what is the cost of power consumption based on the meter readings?

____

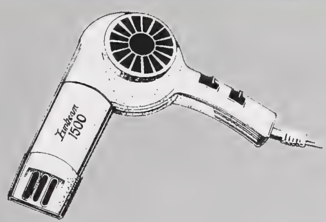
c. How would this cost compare during the winter or summer months? Why?

____

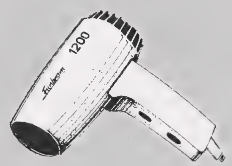
____

Here is an advertisement for two different hairdryers.

Power of a Hairdryer



Powerful 1500 watts for quick drying. Regulated drying control: on/off, heat control, fan control, four comfort settings. Complete with air concentrator attachment. Model #4866.



Quiet, turbo fan operation with two heat/speed combinations, 300 – 1200 watt output, dual voltage. Folding handle for compact storage. Model #4871.

41. Examine the advertisement for the two hairdryers. Which hairdryer has the most power? The 1500-watt hairdryer costs $2 more than the other. Which one is the better buy? Why?

____

____

____

____

Check your answers by turning to the Appendix, Section 2: Activity 4.

If you have access to school laboratory facilities, do the investigation in Part A. If you do not have access to school laboratory facilities, do the investigation in Part B.

Part A

Investigation: Measuring the Power of a Light Bulb

In this investigation you will be using two devices that measure electricity. The ammeter measures how much current is flowing through a wire. This is called amperage (A). The voltmeter measures voltage (V) which is the difference in electrical energy as the current crosses the bulb.

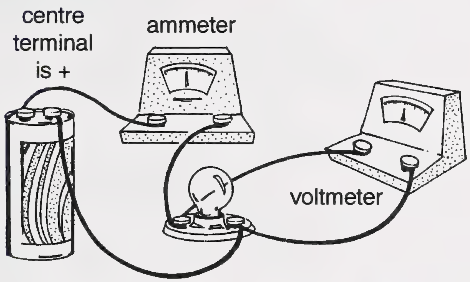
Materials You Need

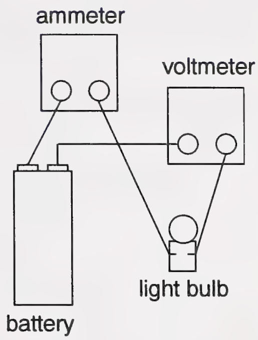
- dry cell battery, 1.5 V
- DC voltmeter, 0 – 5 V
- DC ammeter, 0 – 5 V
- light bulb, 1.5 V
- lamp socket
- 5 electrical wires

Steps to Follow

STEP A

Set up the apparatus as shown to the right. Make sure that all connections are tight.





STEP B

When the bulb lights and the pointers on the two meters are functioning correctly, read and record the values of the two meters.

Note: If the bulb or meters are not working properly, try changing the wires on the ends of the terminals. There may be a defective device.

OBSERVATION

Voltage = ____________________ volts

Current = ____________________ amperes

Conclusion

Now you can find out how much power the light bulb uses. Electric power is a measure of the rate at which electricity is used. The unit used is the watt. The following formula is used:

$$\boxed{\text{power} = \text{current} \times \text{voltage}}$$

In terms of units this is equivalent to the following:

$$\boxed{\text{watts} = \text{amperes} \times \text{volts}}$$

42. Using the formula, substitute your data for volts and amperes, to find watts. How many watts of power did the light bulb use?

Electrical appliances have a wattage rating stamped on their serial number label.

43. Check the wattage of several light bulbs. List three ratings and indicate where the light bulbs are used.

Rating	Use of Bulb

Check your answers by turning to the Appendix, Section 2: Activity 4.

Part B

Investigation: Watts in a Hairdryer

In this investigation you will learn about one electric device, the hairdryer, and the power it emits.

Materials You Need

- 1 hairdryer

Steps to Follow

STEP A

Locate the information label on a hairdryer.

An example of an information label is given.

Model # RJL200 125 V AC 60 Hz 1200 W Made in Canada

STEP B

Record the model number, the number of volts, and the number of watts in the observations table.

OBSERVATION

model #: ____________________

voltage: ____________________ volts

power: ____________________ watts

44. Repeat this investigation with another home appliance such as a toaster and record the following information:

appliance : ______________________

model #: ______________________

voltage: ______________________

watts: ______________________

Conclusion

To find out how much energy the hairdryer uses, you multiply the watts by the time you have the appliance turned on.

Look at the sample label. It shows the hairdryer having a rating of 1200 watts. If the dryer was used for 1 hour it would need the following amount of energy:

$$1200 \text{ W} \times 1 \text{ h} = 1200 \text{ W•h of energy}$$

Defining 1 watt as 1 joule per second gives the following equation:

$$\begin{aligned} \text{Energy} &= 1200 \text{ J/s} \times 3600 \text{ s} \\ &= 4\,320\,000 \text{ J} \\ &= 4\,320 \text{ kJ} \\ &= 4.32 \text{ MJ} \end{aligned}$$

The hairdryer would use 4.32 megajoules of energy in an hour.

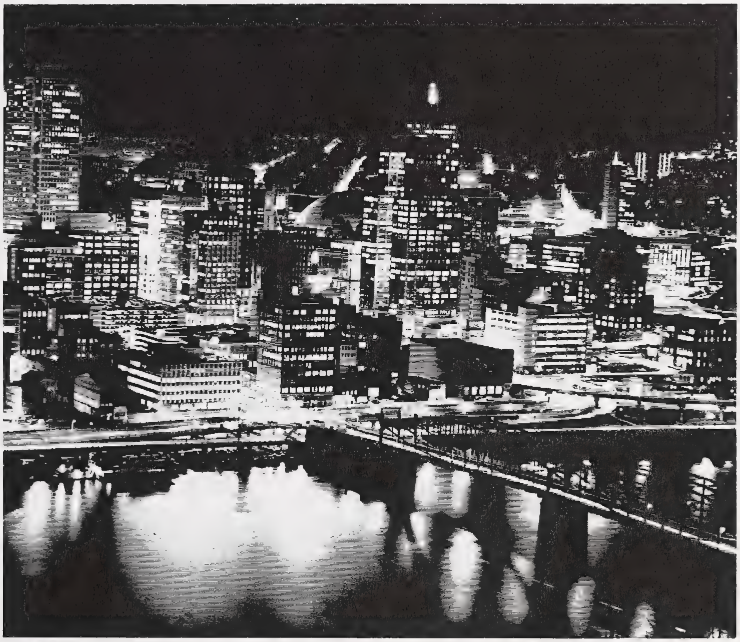
45. How much energy would your hairdryer use in one-half of an hour?

The joule is a very small unit so it is changed to kilowatt hours. A kilowatt hour is an energy unit and watt is a power unit.

1 kilowatt-hour is 1000 watts used for 1 hour.

46. How many kilowatt-hours are used by a 100-watt bulb that is on for 10 hours?

47. The word *watts* is written on the top of a light bulb. In terms of brightness, how would you compare a 200-watt bulb to a 40-watt bulb?



48. The bright lights of a city require a great deal of electricity. Why is this essential?

Check your answers by turning to the Appendix, Section 2: Activity 4.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

1. Different foods have different amounts of energy. Energy is measured by burning the food to see how much heat is given off. The heat energy is measured in kilojoules (a joule is too small). Use the following food categories to name an example that has a low energy value. Check the tables in the Appendix if you require more help.

   a. seafood ______________________

   b. poultry ______________________

   c. fresh berries ______________________

   d. low fat dairy ______________________

   e. gelatin ______________________

2. Energy cannot be destroyed. It has the capacity for doing work and it can be converted from one form to another. Use the list of kinds of energy to do the following:

   - Identify which form is used by each situation.
   - Explain any energy change that takes place.

• light	• electrical
• heat	• nuclear
• sound	• mechanical
• chemical	

   a. A ballerina dances.

   ____

   b. A tomato plant grows.

   ____

c. A TV is turned on.

d. A pot of water boils.

e. A power plant produces electricity.

f. A saw cuts wood.

g. A jackhammer works.

3. Explain why any six of the foods in this shopping cart are high in energy.

4. Which forms of energy can be associated with the sun?

Electrical energy in your home is measured in kilowatt-hours. Select two kitchen appliances and two different kitchen lights to answer the following questions.

5. Find the total number of watts that would be used if the two lights and appliances are switched on at the same time in the kitchen. (Hint: Look at the appliance labels to find their wattage rating. Light bulbs have the watts stamped on the glass).

   a. What is the total number of watts used in the kitchen?

   b. How many kilowatts of power does everything use?

   c. If you left the four items on for 1 hour, how much electrical energy would be used?

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

Do **one** of the following.

1. Determine what costs more to run, appliances with heating elements (e.g., toasters, irons, clothes dryer) or those with motors (e.g., mixers, blender, washing-machine).

2. Read the electrical meter at home at two intervals and calculate the electrical energy used and its cost. Compare your results with the previous or next power bill.

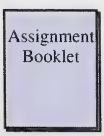
3. Find out how many kilojoules per hour are used in bike riding, walking, running, or swimming.

4. Visit your local mall or shopping centre. How many light fixtures are needed in an average shoe or dress store? How many electrical appliances are needed by the store in order to operate? Why?

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you have studied various forms of energy, and you were able to measure or calculate these different forms of energy. For example, the energy in food can be measured in a calorimeter. A sample of the food is burned and the heat given off is measured in kilojoules. Other forms of energy can also be measured. Fuels like natural gas are measured in larger units such as megajoules or gigajoules. The loudness of sound is measured in decibels. Household electric energy is measured in kilowatt-hours.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

Section

3

Efficient Energy Consumption

ALBERTA FIELD CROP RESEARCH

Your lifestyle helps determine the amount of energy that you consume. Could you name which energy form you consume the most?

In this section you will measure how much food energy you use based on the activities that are part of your lifestyle. As well, you will consider the amount of electrical energy you use in your home. Some energy conservation methods will also be considered. These could reduce the cost of energy that your lifestyle dictates. It may help you to become a more responsible consumer of energy.

Activity 1: Lifestyles and Energy Consumption

How would your lifestyle change if you won a lottery? Would your dependence on energy be less or more than it is now?

Did the early Alberta pioneers use as much energy in one day as you do today? Probably not! You might use cosmetics, clothes dryers, stereos, cars, or instant foods which require energy to make or use. These products take a great deal of energy to manufacture and sell to you. When you enjoy this kind of lifestyle, much energy may be wasted.

Fossil fuels such as petroleum, natural gas, and coal are used as fuel energy and to make plastics, chemicals, and many other convenience products. Once the fossil fuels are used they cannot be replaced. For this reason they are considered as a **nonrenewable** energy source.

nonrenewable – an energy resource, such as fossil fuels, that cannot be replaced once it is exhausted

1. Name four common examples where large amounts of energy are used for non-essential goods or services.

____

____

____

____

2. Name four common examples where fossil fuel energy is used.

____

____

____

____

3. Name four common examples where energy is wasted.

____

____

____

____

4. Why are fossil fuels considered a nonrenewable energy source?

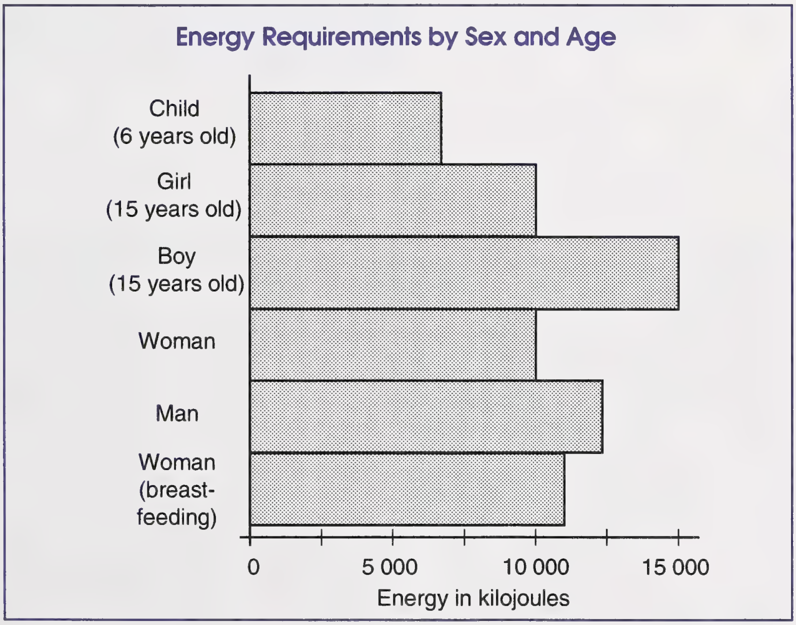
____

____

Check your answers by turning to the Appendix, Section 3: Activity 1.

People who are overweight would like to use some of the stored energy on their bodies. How much energy do you really need?

To maintain your weight and supply energy for growth, you require 126 kJ to 168 kJ for each kilogram of your mass. If you are more active, you need even more food energy. Use this graph to answer the questions that follow.



5. How many kilojoules of energy do you need each day based on the preceding graph and the energy requirement that most closely describes you?

____

6. Assuming you need 140 kJ/kg of body weight, calculate the kilojoules of energy you need to stay at your present mass.

   140 kJ/kg × ______________ (your weight in kg) = ______________ kJ

7. What factors would increase or reduce the number of kilojoules of energy your body needs?

   ____

   ____

8. What sex and age group requires the most energy? Why?

   ____

   ____

Check your answers by turning to the Appendix, Section 3: Activity 1.

"How can she eat so much and never gain weight?"

basal metabolic rate – the rate at which energy is used at complete rest; energy used to maintain life processes such as breathing, digestion, and blood circulation

Have you heard people comment that they gain weight just by looking at fattening foods? There are many factors that influence whether you gain weight easily. Some people have a higher **basal metabolic rate** (BMR) than others. This is the number of kilojoules you need just to stay alive for 24 hours.

Here is an example for you to follow. Assume a person's mass is 70 kg.

$$\begin{aligned} \text{BMR} &= (4.2\ \text{kJ}) \times (\text{body mass in kg}) \times (24\ \text{hours}) \\ &= 4.2\ \text{kJ} \times 70\ \text{kg} \times 24\ \text{hours} \\ &= 7056\ \text{kJ/day} \end{aligned}$$

9. What is your basal metabolic rate?

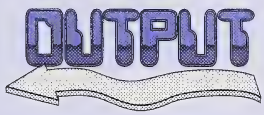
___

To find out how many kilojoules of energy you need per day, you have to add the energy you use up doing your daily activities to your BMR energy. The following table gives you some approximate values for energy output. A more complete table appears in the Appendix.

10. Use the table to calculate your average daily energy output.

___

Energy Output



Activity	Energy Used in kJ/h
Sleeping	260
Sitting quietly	420
Sitting but working	630
Standing, light work	630
Sitting, light work with walking	740
Sitting, heavy work	760
Walking, brisk	1060
Walking, some lifting and pushing	1270
Bicycling	1550
Swimming	1800
Heavy work	1850
Heaviest work	2320
Jogging	2520
Cross-country skiing	2900

11. If you plan to lose weight, how would your diet be different?

____

____

12. If you plan to lose weight, how would your energy output be different?

____

____

13. Use the following table to record the energy you use in a typical day. List all your activities, beginning at midnight and ending at midnight the following day. Use fractions for activities that take less than 1 hour. Space is available to add activities not on the list.

Activity	Time Performed	Energy Burned in kJ
BMR		
sleeping		
dressing, showering		
eating		
standing		
driving		
talking		
schoolwork		
watching TV		
housework		
sports		
dancing		

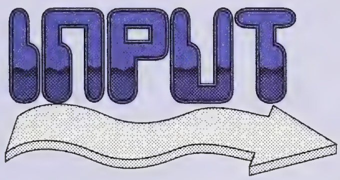
Activity	Time Performed	Energy Burned in kJ

TOTAL kJ = ________________

All that's left is to calculate how many kilojoules of energy you normally eat in a 24-hour period. Choose a typical day, not one where you are very busy or are very inactive. Record all the food and beverages you consume in one day.

The following table shows the energy value of some foods. A more complete table appears in the Appendix.

Energy In Food (Per Single Serving)



Food	Energy in kJ	Food	Energy in kJ
Apple juice	250	Cheeseburger	1900
Bacon, 4 slices	1030	Chelsea bun	665
Beans – baked	650	Coffee, cream and sugar	360
– green	65	Custard	600
Beef – ground	1000	Doughnut	525
– rib roast	1575	Jam and jelly	460
– sirloin steak	1385	Lamb chop	1680
Beef stew	880	Liver, beef	545
Butter	150	Lunch meat	350
Cabbage roll	1100	Mayonnaise	420
Cake with icing	1680	Milkshake	1175
Candy bar	540	Peanuts	880
Cereals – dry	460		
– cooked	540		

14. Fill in this table to find your daily energy input. (Multiply by 2, if you have two portions, to get amount of kilojoules.)

Input Energy

Food and Beverage	Amount Eaten	Energy Consumed in kJ

Food and Beverage	Amount Eaten	Energy Consumed in kJ

TOTAL kJ = ________________

15. How many kilojoules of food energy did you eat? Are you eating more or less food than you use?

____

____

16. If you are not gaining weight by taking in too many kilojoules of food energy, can you give a reason why you would be gaining weight?

____

____

Check your answers by turning to the Appendix, Section 3: Activity 1.

Did You Know?

One small candy bar has about as much sugar as 1.5 kg of apples.

You now have some understanding for helping you maintain your weight in a scientific manner. You know how to measure the amount of food energy you need. How could you measure how much electrical energy is used in your home?

You could apply these same skills to measuring other energy consumptions at a home, school, farm, or business. For example, you might want to know how much it costs to take a bath or a shower.

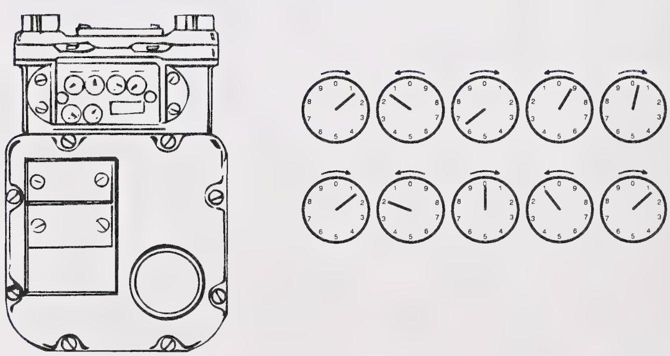
17. What other uses in the home depend on hot water?

18. Besides large household appliances, what gadgets in the home consume energy?

In Alberta, the energy to heat the water for your bath or shower likely came from natural gas. A gasline enters your house from a main supply line. The amount of cubic feet or cubic metres of gas that you use is measured by a gas meter.

The heat from burning the natural gas warms the water in the water heater. Have you ever been the last person in your family to take a shower or bath? Was all the hot water used up before it was your turn?

Gas Meter



19. Which of these appliances are powered by natural gas? Which can also be powered by electricity? Write **G** for gas, **E** for electricity, or **B** for both in the space provided.

Appliance	Energy Power
a. hot water heater	______
b. furnace	______
c. toaster	______
d. garage heater	______
e. clothes dryer	______
f. washing-machine	______
g. lawnmower	______
h. stove	______
i. barbecue	______
j. fireplace	______

The gas utility company usually hires people to go from house to house to read the meter. Today many people may receive a small card reminding them to report the meter reading themselves.

The newest device now uses computer technology. A small device is added to the existing meter. Each month it transfers your meter reading to the utility company's computer via the telephone line.

20. What is the most expensive user of natural gas in your home?

______

21. What do people use to heat their homes in Central Canada where natural gas is not found as commonly as it is in Alberta?

______

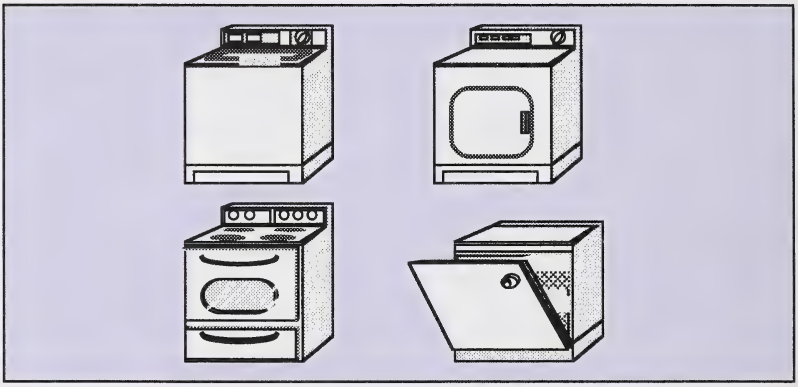
Check your answers by turning to the Appendix, Section 3: Activity 1.

Do you know how the utility company knows what to charge your household each month for electrical consumption? How much power do you use in your household on an average day? Do you know what your family pays per year for electricity?

Did you watch TV or use a lamp today? You or someone else pays for the electricity that you use. Can you determine the cost of electricity for daily living activities?

The electric utility company does not keep track of each appliance. It measures the total amount of electricity that goes into your house. The electric meter is much like the speedometer in your car.

The electrical household appliances illustrated in the following diagram will be used in the questions for calculating the cost of electrical power.



22. What two factors affect the amount of electricity used by appliances?

____

____

Once you know the wattage of an appliance, you can find out how much energy it uses per day, per month, and per year.

$$\boxed{\text{Energy used} = \text{watts} \times \text{time used}}$$

Appliances that are on all the time such as refrigerators, furnaces, air conditioners, waterbed heaters, and such, consume large amounts of energy. Appliances with heating elements in them use much energy.

If you turned all the lights on in your house for one hour, what steps would you follow in calculating the amount of electrical energy you would use in kilowatt-hours? The steps are outlined in the following chart.

1. Record the wattage of all light bulbs in the house. Check the light bulbs on the ceiling, walls, and appliances.
2. Add the wattage to get a total and multiply by one hour.
3. The energy is now expressed in watt hours.
4. Divide watt hours by 1000 to get kW•h.

Remember, each appliance has a label that indicates its power rating in watts. Study the following table. It shows the power rating in watts and the average monthly use of several electrical appliances.

Electrical Appliance Power Rating

Appliance	Power Rating (W)	Time (h)	Appliance	Power Rating (W)	Time (h)
Air conditioner	935	65 to 425	Lawn mower	1 500	2
Blanket	180	55	Lighting		
Block heater	500	90	table lamp	100	80
Can opener	175	2	5-bulb fixture	300	30
Clock	2	744	Ceiling fixture	60	35
Clothes dryer	4 800	17	Radio	5	200
Coffeemaker	900	7	Range, standard	12 500	8
Deep-fat fryer	4 800	17	Refrigerator, frost-free	500	300
Dehumidifier	350	45	Stereo	30	200
Dishwasher	1 300	14	Sun lamp	280	4
Floor polisher	300	4	Toaster	1 150	3
Food-waste disposer	450	6	TV, black-and-white	200	150
Freezer	425	200	TV, colour	330	125
Frying pan	1 150	14	Vacuum cleaner	800	6
Furnace fan	250	400	Waffle iron	1 120	2
Hairdryer	1000	9	Washing-machine,		
Humidifier	100	100	automatic	500	16
Iron	1 000	12	Water heater	4 500	115
Kettle	1 500	8			

23. Which appliance uses the most energy per month?

____

24. a. Choose three appliances from the chart. Fill in the data on the table that follows and calculate the energy used.

Appliance	Wattage	Time used per month	Kilowatt-hours (kW•h)

b. Which one of your appliances used the most energy?

____

25. Assume you also used 30 kW•h of energy to light your house for one month.

a. How many kilowatt-hours (three appliances plus lights) did you use in one month?

____

b. If the utility company charges eight cents per kilowatt-hour, how much did you pay for electricity for the month?

____

Check your answers by turning to the Appendix, Section 3: Activity 1.

Investigation: Electric Meter Reading

You will monitor electric usage in your home for a 24-hour period and a 7-day period. (Do not read the gas or water meter.) You will also prepare an observation table to record your readings.

Materials You Need

- electric meter
- paper and pencil

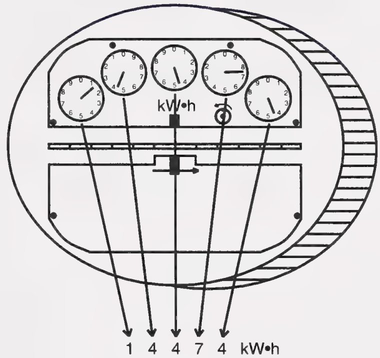
Steps to Follow

STEP A

Locate the electrical meter in your house or dwelling.

Read the meter every 24 hours for 7 days. Make your reading at the same time each day, such as every morning, noon, or before bedtime.

Read the dial from left to right. If the dial is between two numbers, read the lower number. The meter may have four or five dials.



STEP B

Record the meter reading each day in the observation table.

Subtract the first reading from the second reading for each reading during the 7-day period.

Observation Table

26. Prepare an observation table in the space provided to record your daily meter readings. Your table should have a title and suitable column headings.

Title: ______________________________

27. Can you give a reason for a large usage on a particular day?

____

____

Conclusion

28. How many kilowatts were consumed over the 7-day period?

____

____

29. Find out from the utility company how much the electricity costs. See if you can calculate your electric bill based on the power consumed over the 7-day period.

____

____

30. Ask your parent, friend, or teacher to show you an electrical utility bill.

    a. What was the previous month's usage in kilowatts?

    ____

    b. What is the current month's usage?

    ____

    c. What was the number of kilowatt-hours of electricity that was used?

    ____

    d. What was the power bill for the month?

    ____

Check your answers by turning to the Appendix, Section 3: Activity 1.

Activity 2: Clean Up Your Act

Does a fast food lifestyle use a great deal of energy?

Does a high fashion lifestyle use a great deal of energy?

What plan could you devise to encourage people to use energy more wisely? What plan could you follow to use energy more wisely?

If you look around your home, school, or place of work, you would find a number of areas where energy is not being used efficiently. There are many plans and recommendations from government and other sources that could reduce energy costs if followed.

1. What probably accounts for the greatest consumption of energy in Alberta? Why?

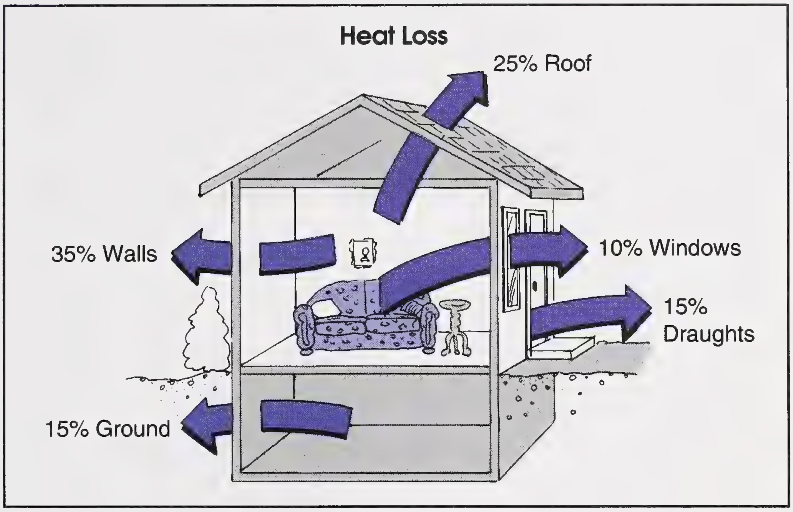
____

____

You would be correct if you identified the heating of homes and buildings as the largest consumer of energy in Alberta. In fact it accounts for about 60% of the total energy consumed. Were you able to answer why?

Heating houses and buildings in Alberta and the rest of Canada is expensive.

Heat losses from homes and buildings add to the cost of heating them. Typical heat loss in houses is illustrated in the following diagram.



Some of the likely causes for heat loss could include the following:

- leaky doors and windows
- doors that don't have an automatic closing device
- cracks around wall sidings and block foundations
- overheating of some areas
- thermostats not lowered during nonuse periods
- weatherstripping needing replacing
- poor or inadequate insulation in roof, walls, and foundation
- furnace fans not properly maintained
- furnace and furnace filters needing changing or cleaning
- air exhaust fans running too fast
- trapped hot air in high ceiling areas lost through the roof as waste heat

2. a. What three areas in your house or school are likely sources for heat loss? How can you tell?

____

____

____

____

b. What are possible solutions for the heat losses you identified?

Use the following sketch to answer the next questions.

Energy Losses

3. Examine the sketch to identify at least five areas where energy is wasted. Suggest where the energy is wasted and what the solutions are.

4. Using the sketch as a guide, suggest five ways in which energy can be conserved through wise or efficient use.

5. Read the statements that follow. Decide if the statement is true or false. If it is false, rewrite it to make it true.

   _______ a. It is possible in winter to keep my home fairly cool and wear a sweater to keep warm.

_______ b. Energy can be conserved by turning off lights and appliances when not in use.

_______ c. Incandescent lights consume less electrical energy than fluorescent lights.

_______ d. Toasting one slice of bread at a time in a toaster does not waste energy.

_______ e. Washing dishes consumes more energy than using throw-away containers, plates, and cutlery.

_______ f. Waterskiing, motorboating, and snowmobiling do not consume much energy.

_______ g. Having your car tuned-up has no effect on fuel consumption.

______ h. You would not save money by switching a truck fuel tank to propane.

____

____

______ i. Energy can be saved by cleaning light bulbs; dirt absorbs light which reduces intensity.

____

____

______ j. Taking a shower consumes less hot water than taking a hot bath.

____

____

Check your answers by turning to the Appendix, Section 3: Activity 2.

Follow-up Activities

If you had some difficulty understanding the concepts and the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

What was your energy intake yesterday? Young people normally need about 12 000 kJ per day. This depends on how active a person is, and if you are male, you may need slightly more. About half of this energy is used to keep your body's basic functions running. Your heart beats and your lungs breathe. The rest of the energy is used to move. If you don't eat enough, you won't have enough energy. If you eat too much, you will put on weight.

Modern advertising tries to convince you to buy many luxury or extravagant items such as new cars, trips, or clothes. Some items, like excessive packaging and plastic containers, are clearly energy wasters and pollution sources.

1. Assume that your body needs 6 000 kilojoules each day just to live. You played soccer for 2 hours and watched TV for 2 hours yesterday. How much energy did you use? (Use the table in the Appendix or in this section to calculate how many kilojoules you used.)

Activity in kilojoules × time = kilojoules used

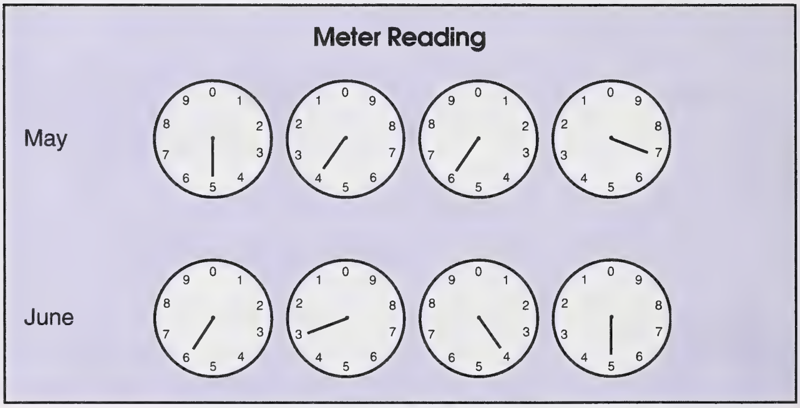
____

2. What are some activities that use a great deal of energy?

____

____

Read the following dials on an electric meter to answer the questions that follow.



3. a. What was the meter reading in kW•h during May?

____

b. What was the meter reading in kW•h during June?

____

c. How much electricity was used in one month?

____

4. Which of the following products or services are excessive energy consumers? Explain.

   - delivering pizza
   - riding your bicycle to work or school
   - drying one shirt in the dryer
   - keeping the room temperature at 22°C
   - flying a private jet
   - using the oven to heat a room
   - buying an assortment of cosmetics
   - making dinner from raw vegetables
   - keeping your car engine tuned-up

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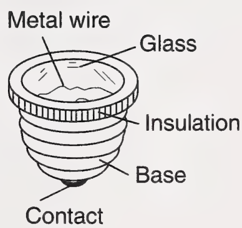
Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

Do **one** of the following activities.

1. Examine how fuses, circuit breakers, or ground fault circuit interrupters (outside or inside bathrooms) operate to prevent an overload of electric current through the circuit.



2. Rate a fad diet. Use Canada's Food Guide and the activity chart in the Appendix.

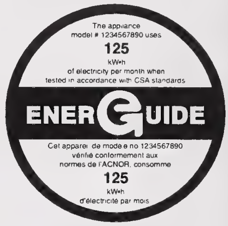
3. a. What is the total amount of energy consumed in one hour by all the fluorescent lights in your classroom? (Hint: A regular fluorescent bulb usually is 40 W.)

   b. If this energy costs eight cents per kilowatt hour, what does it cost to keep all the room lit up during lunch hour?

   c. If lights were turned off during lunch hour, what would the school save in one month?

4. Locate the Energy Guide label on three appliances. You may find this easier to do by visiting a store that sells appliances.

   Assume you are planning to buy a new refrigerator. Do some comparison shopping to find the most energy efficient model.



5. Use the Energy Guide on labels of three appliances in your home and calculate the amount of electricity they use in one year. Contact your utility company to find the charge per kilowatt hour and calculate what these appliances cost to use for one year.

6. Compare the cost of operating appliances with heating elements to those with motors.

7. Monitor the energy consumption in your home or school for one month. Devise an improved system for using energy in your home or school.

8. Compare the efficiency of 40 W fluorescent and 40 W incandescent lamps in terms of power rating and brightness (lumens). Hold your hand near both after they have been on for 10 minutes to assess which bulb converts more electrical energy into heat energy.

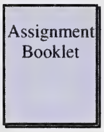
Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you were able to calculate the amount of energy required in two situations. From these calculations you were then alerted to the reality of consuming too much energy. Specifically you can calculate the amount of food to eat to create the minimum amount of energy necessary to maintain your body mass. If you consume more energy than you use you will gain mass.

You can also measure how much electrical energy is used in your daily activities. Reducing waste energy is important as you must pay for this waste.

Your lifestyle affects your use of energy.



ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

MODULE SUMMARY

Energy powers your life and your everyday activities. You need energy to stay alive and to run your machines.

Energy cannot be created nor destroyed but can be changed from one form into other forms. The sun is the ultimate source of all energy. Solar energy results from the nuclear changes occurring within the sun. Radiant solar energy reaching Earth is changed into stored chemical energy during photosynthesis. All energy forms on Earth, whether they be light, heat, mechanical, electrical, or sound energy, can be traced back to the sun.

Energy can be measured and personal energy consumption can be determined. Wasted energy is expensive. You can make lifestyle changes in order to conserve energy and reduce its waste. This stored energy is then transformed into mechanical and heat energy within your body.

Appendix

- Glossary
- Activities
- Extra Help
- Enrichment

Glossary

basal metabolic rate
- the rate at which energy is used at complete rest; energy used to maintain life processes such as breathing, digestion, and blood circulation

calorie
- the amount of heat needed to raise 1g of water 1°C

calorimeter
- a device or container that uses temperature changes in water to calculate heat energy

carbohydrate
- a molecule such as sugar, starch, or cellulose that contains carbon, hydrogen, and oxygen

chemical energy
- energy needed to hold atoms together when they make molecules

control variable
- a factor in an experiment that is kept constant so that it does not affect the outcome of the results from one trial to another

decibel
- unit of relative loudness or difference in power between sound or electrical signals

electrical current
- the number of electrons that flow through a wire per second

electrical energy
- energy resulting from movement of electrons through a substance

electrical power
- the rate at which electrical energy is consumed

energy
- the capacity for doing work

enzyme
- a substance, formed in plant and animal cells, which speeds up or slows down a chemical reaction without being chemically changed itself

force
- a push or pull in a certain direction

frequency
- the number of times an event occurs in a given interval of time, such as vibrations per second

glucose
- a simple sugar occurring naturally in fruits and honey
  It is the primary source of energy for practically all living organisms.

joule
- work done when a force of one newton (N) moves through a distance of one metre in the direction of the force

kilowatt-hour
- unit of electric power used or the total energy developed by a power of one kilowatt acting for one hour

kinetic energy	• energy possessed by any moving object
manipulated variable	• a factor in an experiment that can be altered to affect the outcome
mechanical energy	• energy of moving parts whether they actually move or are only capable of motion
nonrenewable	• an energy resource, such as fossil fuels, that cannot be replaced once it is exhausted
nuclear energy	• energy released when the nucleus of an atom splits or combines with another
nutrients	• any substances, such as vitamins and minerals or ingredients in food, that nourish living things
photosynthesis	• a process by which green plants produce carbohydrates and oxygen from carbon dioxide and water in the presence of light and chlorophyll
polarity	• tendency of an object to have one of two separate and opposite characteristics
potential energy	• a form of stored energy resulting from the position of an object that has the potential to be released
radiant energy	• energy transferred by radiation such as light and heat
respiration	• a process in which animals release energy, carbon dioxide, and water by reacting carbohydrates and oxygen in body cells
responding variable	• the factor in an experiment that is affected by the change in the manipulated variable
SI unit	• any standard or derived units that are a part of the Systéme International d'unites from which all scientific measurements are made
solar collector	• device used to capture radiant energy from sunlight
sound energy	• energy produced by vibration of atoms or molecules
starch	• complex molecule occurring naturally in potatoes, cereals, etc. made from many sugar molecules
thermal or heat energy	• form of energy arising from motion of atoms or molecules

translucent • substance through which light passes but through which one cannot see through clearly

watt • an SI unit of power equal to one joule per second

work • the application of a force through a distance

Food	Measure	Weight (g)	Food Energy (kJ)
Milk Products			
cheddar cheese	15 mL	7	710
cottage cheese	250 mL	237	1020
cream	15 mL	16	200
powdered creamer	5 mL	2	40
whipping cream	250 mL	252	3640
whole milk	250 mL	257	660
2% milk	250 mL	258	540
skim milk	250 mL	258	380
buttermilk	250 mL	258	430
evaporated milk	250 mL	356	1490
ice cream	125 mL	70	590
ice cream (soft)	125 mL	95	600
yogurt with fruit	125 mL	74	530
Eggs			
egg (cooked in shell)	1 egg	50	330
egg (scrambled in butter)	1 egg	64	400
fried egg	1 egg	46	350
egg substitute	125 mL	126	790
Meat and Meat Products			
wiener	1 weiner	50	520
ground beef	1 pattie	90	1080
roast beef (in oven)	2 pieces	90	1570
steak (broiled)	1 piece	90	1330
cod (broiled)	1.5 fillets	90	640
cod (pan fried with butter)	1.5 pieces	90	960
bacon	1 slice	15	380
ham	2 pieces	90	1410
pork chop	1 chop	98	1090
chicken breast (fried)	1 piece	76	650
chicken (roasted)	1 piece	90	510
turkey (roasted)	1 piece	90	720

Food	Measure	Weight (g)	Food Energy (kJ)
Vegetables and Related Products			
red kidney beans	250 mL	90	1570
peas	250 mL	90	1330
chick peas	250 mL	90	640
asparagus	250 mL	90	960
yellow beans	250 mL	15	380
bean sprouts	250 mL	90	1410
beets sliced	250 mL	95	240
broccoli	250 mL	164	180
carrots (diced)	250 mL	153	200
cauliflower	250 mL	127	110
celery	250 mL	133	80
corn	250 mL	175	620
corn (creamed)	250 mL	243	760
lettuce	250 mL	78	40
mushrooms (canned)	250 mL	257	180
mushrooms (fresh)	250 mL	257	120
onions (raw)	250 mL	222	260
onions (fried)	250 mL	184	1560
parsnips	250 mL	169	440
peas (cooked)	250 mL	169	510
potato (medium baked in skin)	1	100	380
potato (boiled)	1	136	440
french fries	10 pieces	57	650
mashed potatoes (milk added)	250 mL	206	550
mashed potatoes (butter added)	250 mL	206	820
spinach (raw)	250 mL	32	40
spinach (cooked)	250 mL	190	180
tomato (raw)	1	150	35
Fruits and Related Products			
apple (raw)	1	150	290
applesauce (canned)	250 mL	269	1020
banana	1	175	420

Food	Measure	Weight (g)	Food Energy (kJ)
canteloupe	1/2 melon	385	250
cherries	250 mL	137	400
cranberries	250 mL	100	190
grapefruit (white)	1/2	241	190
grapefruit (pink)	1/2	241	210
grapefruit juice (canned concentrate)	1 can	207	1260
grapes	250 mL	169	420
grape juice (frozen concentrate)	1 can	216	1650
lemon juice (fresh)	250 mL	257	260
lemonade (frozen concentrate)	1 can	219	1800
orange (raw)	1	180	270
orange juice (fresh)	250 mL	262	490
orange juice (frozen concentrate)	1 can	213	1510
peach (whole)	1	114	150
peaches (sliced)	250 mL	177	290
peaches (canned and syrup added)	250 mL	271	880
pineapples (raw)	250 mL	269	330
pineapples (canned with heavy syrup)	250 mL	274	860
raisins (seedless)	250 mL	174	2120
raisins (25-mL pack)	1 package	14	170
watermelon	1 slice	925	480
Breads and Wheat Products			
bread, white enriched	1 slice	30	340
bread, 60% whole wheat	1 slice	30	300
raisin bread	1 slice	25	270
bread, French or Vienna	1 slice	34	410
cinnamon bun	1	50	660
commercial hard roll	1	40	520
hotdog bun	1	50	570
hamburger bun	1	60	690

Food	Measure	Weight (g)	Food Energy (kJ)
Desserts			
brownie	1	20	400
chocolate chip	1 cookie	10	210
chocolate marshmallow	1 cookie	19	310
pancake	1	27	250
apple pie	1 sector	160	1720
cherry pie	1 sector	160	1620
lemon meringue pie	1 sector	140	1490
pumpkin pie	1 sector	150	1330
popcorn (salt and oil)	250 mL	9	170
potato chips	10 chips	20	480
chocolate eclair with custard filling	1 piece	110	1320
Combination Plates			
cabbage rolls with meat	2 rolls	206	1090
chili con carne	250 mL	264	1470
chop suey with meat or poultry	250 mL	163	790
chow mein chicken	250 mL	184	780
egg rolls (pork)	2 rolls	146	2000
irish stew	250 mL	211	1240
fish stew	250 mL	237	600
lasagne	1 slice	180	1100
macaroni and cheese	250 mL	231	2080
meat loaf	1 slice	70	110
pizza, cheese	1 sector	75	740
pizza, sausage	1 sector	105	1030
spaghetti with meatballs	250 mL	260	1460
tourtiere (pork pie)	1 sector	139	1890
Beverages			
cola	200 mL	197	320
gingerale	200 mL	195	260
coffee (instant)	250 mL	235	20
tea (instant)	250 mL	224	0

Food	Measure	Weight (g)	Food Energy (kJ)
beer (1 bottle)	341 mL	360	630
gin, rum, vodka, whiskey	50 mL	47	490
orange juice (fresh)	250 mL	262	490
orange juice (frozen concentrate)	1 can	213	1510
grapefruit juice (canned concentrate)	1 can	207	1260
whole milk	250 mL	257	660
2% milk	250 mL	258	540
skim milk	250 mL	258	380
buttermilk	250 mL	258	430

Food Type	Mass (g)	Energy (kJ)	Walk (min.)	Jog (min.)	Swim (min.)
cola (227 mL)	240	483	20	11	12
popcorn (buttered)	18	344	16	8	10
chocolate chip cookie	11	210	10	5	6
ice cream cone	72	672	31	16	19
banana split	300	2494	114	59	71
jelly doughnut	65	949	44	23	27
cheeseburger	180	1940	89	46	55
french fries	100	1150	53	27	33

Type of Activity	Energy Factor kJ/h
sleeping	4.1
sitting	5.2
writing	6.0
standing	6.3
singing	7.1
typing, playing cards	9.0
washing car, cooking	10.5
playing piano	11.2
walking (3.2 km/h)	11.6
bowling	13.6
bicycling (3.0 km/h)	15.8
walking (4.8 km/h)	16.2
walking (6.4 km/h)	20.6
badminton	21.5
soccer	23.2
bicycling (15.3 km/h)	25.8
hiking, fast dancing	27.0
tennis, downhill skiing	36.2
climbing stairs, running (8.8 km/h)	37.5
bicycling (20.9 km/h)	40.5
cross-country skiing	42.0
swimming crawl (45.7 m/sec.)	49.1
handball	49.5
running (12.9 km/h)	62.0
competitive cross-country skiing	73.6

* Energy expenditures per kilogram of body mass.

Suggested Answers

Section 1: Activity 1

1. Some foods that are high in energy could include candy, cakes, pastry, desserts, alcoholic drinks, soft drinks, chocolate, jam, nuts, sweetened cereals, processed meats, bread, rice, and pasta.

2. Some foods that are low in energy could include coffee, tea, diet soft drinks, spices, and vegetables such as broccoli, brussel sprouts, celery, radish, lettuce, cucumber, cabbage, and raw tomato.

3. The food you eat gets its energy from one or more energy transfers, but ultimately it gets its energy from the sun.

4. The process of photosynthesis can be given as the following:

$$\text{carbon dioxide} + \text{water} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \text{sugar or starch} + \text{oxygen}$$

$$(6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2)$$

5. Some foods that are classified as starch could include potatoes, bread and pastry, pasta, cereals, corn, and rice.

6. a. Energy is directly received from the sun by the potato and parsley.

   b. Energy is indirectly received by cattle (from which the butter originated), and cattle or pigs (from which the meat originated).

7. The grass on which the meat-producing hog depended, the wheat which was made into bread, and the tomato and lettuce obtained their energy directly from the sun during photosynthesis. The meat required several energy transfers before it ended up in the sandwich.

8. The bread or crackers contain starch which was changed into sugars by the chemicals in saliva.

9. a. wheat

   b. sugar beet or sugar cane

   c. tomatoes

   d. mustard plant

   e. cabbage

   f. canola, corn, sunflowers

g. wheat

h. cocoa plant

10.

Type of Seed or Substance	Original Colour	Colour with Iodine Indicator
corn	yellow-white	blue-black
wheat	brown-white	blue-black
navy bean	white	blue-black
flour	white	blue-black
cornstarch	white	blue-black

11. A blue-black colour change should be noted.

12. The same colour change on a normal sheet of paper as with those substances that contained starch is observed.

13. If a drop of iodine and water is placed on a substance and the colour change is blue-black, then the substance contains starch.

14.

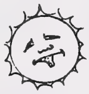
High Starch	Low or No Starch
soda cracker	egg
vegetable soup	coffee
ripe banana	celery
potato chip	white turkey meat
white cake	bacon
	cheese
	lettuce

15.

Type of Oil or Nut	Effect on the Brown Paper
peanut	made the paper translucent
varies	made the paper translucent
varies	made the paper translucent

16. Since they make paper translucent much like the original oil placed on it, nuts must contain oil.

17. The correct order of energy transfers is numbered as follows.

				
2	4	3	1	5

18. The energy transfers should be in the following order: sun → barley → Hereford steer → T-bone steak → woman

Section 1: Activity 2

1. a. mouth
   b. salivary gland
   c. esophagus
   d. stomach
   e. liver
   f. pancreas
   g. small intestine
   h. large intestine

2. Your sense of smell is more acute than sense of taste so most of what you taste is due to smell. Taste is reduced by a cold since your sense of smell is most affected.

3. Saliva lubricates food for swallowing. It also begins to digest starch foods in the mouth.

4. The esophagus is the part of the digestive system that transfers food from the mouth to the stomach.

5. The stomach is a part of the digestive system which receives food and breaks it down with digestive juices.

6. Heartburn is a burning acid sensation in the upper part of the stomach and along the esophagus brought on by eating certain substances such as spicy foods, high-acid foods, and alcohol.

7. What may appear like a stomach-ache could be appendicitis, food poisoning, bacterial infection, or other ailments exhibiting the same symptoms. It is difficult to make an internal diagnosis without medical knowledge.

8. The gelatin begins to break apart and become watery.

9. The meat tenderizer has an enzyme that breaks the protein molecules in the gelatin into smaller molecules.

10. When bile is released by the liver for digestion, trace amounts from the stomach are sometimes brought up with the release of gases from a belch to produce a foul taste of bile in the mouth.

11. The function of bacteria in the intestines is to break down undigestible solid food particles.

12. The large intestine has these two functions:

    - absorbs water from the undigestible solids received from the small intestine
    - forms solid wastes which are eventually eliminated

13. When a grilled cheese sandwich is eaten, the mouth breaks the food into smaller particles, provides saliva lubrication, and begins to digest the starch. The esophagus allows the food to be swallowed or travel into the stomach. The stomach mixes the food around thoroughly, separates it, and breaks it down with gastric juices. The small intestine continues to break the food down and absorbs the nutrients into the blood stream for cell energy. The large intestine completes digestion by producing undigested wastes.

Section 1: Activity 3

1. Answers may vary but could include activities such as brushing teeth and walking to school.

2. Answers may vary but could include activities such as breathing, thinking, muscular movement, digestion, growth, and swallowing.

3. Symptoms may vary, but normally you can tell when your body requires energy if you become hungry, listless, or tired.

4.

Rate	Before jogging	After jogging
pulse rate (beats per minute)	varies; mostly between 55-80	varies
breathing rate (breaths per minute)	varies	varies

5. a. Jogging increased your rate of breathing because your body needs more oxygen for faster cell respiration.

   b. Your heart rate increased to pump more blood which carries the oxygen and glucose to your muscle cells.

   c. Your legs may feel tired because they use up the glucose which is the source of energy. There may also be a buildup of waste products from respiration.

6. a. When you are sick, your immune system has to use more energy to produce cells to fight the disease. You may have a fever which is an increase in the body's production of heat. Therefore, being sick burns energy faster than being healthy does.

   b. Standing burns energy faster because the leg muscles are active.

7. The burning of fuel in a car also releases energy.

8. The process of respiration can be shown as the following:

   sugar or starch + oxygen $\rightarrow$ carbon dioxide + water

   $(C_6H_{12}O_6 \quad + 6\,O_2 \quad \rightarrow 6\,CO_2 \quad + 6\,H_2O)$

9. The process of photosynthesis differs from respiration in these two ways:

   - Chlorophyll and solar energy are required for photosynthesis to occur.
   - Photosynthesis creates sugars and starches; respiration breaks them down.

10. Oxygen is taken into your lungs during breathing. It passes from the lungs into the blood, which carries the oxygen to every cell in your body.

11. The breathing process supplies the body with the oxygen needed for cell respiration and eliminates the carbon dioxide produced during respiration.

12. You breathe at a faster rate during exercise because vigorous exercise requires body cells to burn more glucose. Faster breathing brings more oxygen to the cells for respiration.

13. Your heart beats faster when you exercise more vigorously because hard exercise requires faster movement of the blood to the body cells. Oxygen and glucose need to reach the cells more quickly.

14. Your breathing is at its slowest rate when you rest or sleep since your body cells require less energy than during vigorous activity.

15. Muscles tire when they run out of a supply of readily available glucose. It may be difficult to move your limbs or move at all.

16. A spaghetti dinner eaten before competition would release energy over a longer period of time than a chocolate bar.

17. A chocolate bar eaten during competition would release energy much quicker than a spaghetti dinner.

Section 1: Activity 4

1. Foods that are from the four basic food groups – milk products, meat and alternatives, grain products, and vegetables and fruits – are considered to be nutritious.

2. The foods are considered undesirable food choices because they have little, if any, nutritional value essential for a balanced diet.

3. Some sources for vegetable cooking oil could include olives, peanuts, sunflower, canola, corn, and soybean.

4. Some foods that are cooked using vegetable oil or animal fats could include fries, potato chips, fried chicken, doughnuts, bacon and eggs, hamburger, pastry, processed meats (such as bologna), and pasta.

5. Some snack foods known to contain hidden fats could include peanuts, nuts, sunflower seeds, potato chips, processed meats, cheese, doughnuts, cookies, and candy bars.

6. Nutritionists generally recommend only a moderate dietary intake of fat because fats are known to promote other problems such as heart disease, and the body must also receive a balanced diet of other nutrients.

7. Answers may vary, but the following body parts are largely dependent on protein for their structure: muscle tissue; organs such as skin, heart, or brain; hair and fingernails; or cells such as nerve cells or blood.

8. a. carbohydrate

   b. fat, protein

   c. carbohydrate (fructose, a simple sugar)

d. protein

e. carbohydrate (starch)

f. protein, fat

g. carbohydrate (starch)

h. fat

i. fat (oil from vegetables)

9. a. Vegetables and fruits and adequate milk products are missing from Menu A.

   b. Menu B contains more vitamins and minerals.

   c. Your menu should include the kinds and amounts of foods specified in the Canada Food Guide. You need 2-3 servings of meat and alternatives daily to get your protein. Choose leaner meats, poultry, and fish, as well as dried peas, beans, and lentils more often. You should have 5-10 servings of vegetables and fruit daily to get required vitamins and minerals. Choose dark green and orange vegetables and orange fruit more often. You also need the recommended serving of milk products. As well, you should have 5-12 servings of grain products daily, preferably whole grain and enriched products.

   Your dinner menu should include foods from each of the four food groups. Beverages and condiments should reflect good food choices.

10. Milk products are recommended by Canada's Food Guide to provide essential vitamins, minerals, and proteins that may not be found in other food groups.

Section 1: Follow-up Activities

Extra Help

1. As digestion begins, solid food particles are broken down into smaller units.

2. Melted and original marshmallows are similar to each other because they are still marshmallows.

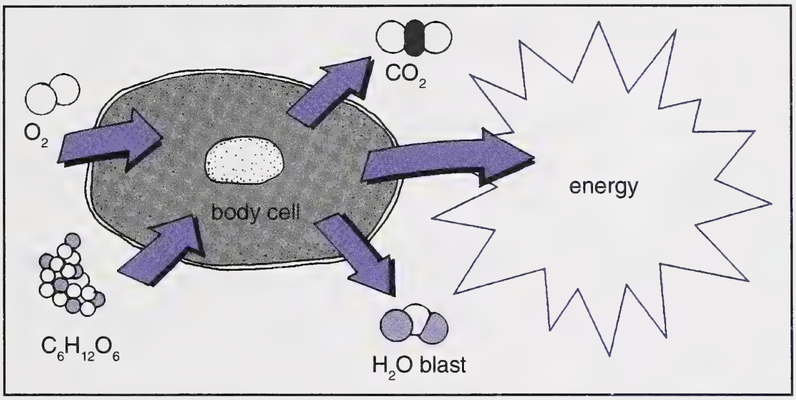
3. Melted marshmallows differ from the original marshmallows because of their state and temperature.

4. Digested food differs from the original food because it has been changed into an entirely different form from the original.

5. The digested food has to be absorbed and moved by the blood system to every body cell. Respiration occurs in all the body's cells. The glucose molecule releases its energy to the cell molecule adenosine triphosphate (ATP). This is the source of energy for all the cells' activities.

6. The missing step is an animal that converts the energy from the corn into meat that people ingest. Cattle, pigs, and chickens may be some suggestions.

7. A diagram of a cell during respiration would be similar to the given figure. Oxygen (O_2) and glucose ($C_6H_{12}O_6$) are inputs which produce the outputs water (H_2O), carbon dioxide (CO_2), and energy.



8. a. The following foods would balance the diet:

   - 1-5 servings of fruits or vegetables
   - 2-3 servings of milk products
   - 1-2 servings of meat, fish, poultry, or other protein alternatives
   - 1-8 servings of grain products

   b. The foods that need to be eliminated are "empty calorie" foods (foods that have only energy value, but no vitamins, minerals, or proteins) like jam and chocolate bars. The white bread provides energy but has few vitamins and minerals. The potato chips are high in fat and would not be suggested to someone who is on a diet.

Enrichment

1. a. Answers may vary. The main function of the pancreas should include its secretion of the enzymes trypsin, amylase, and lipase which continue to digest or break down protein and fats. The liver receives blood sugar or glucose and stores it as glycogen, a form of carbohydrate, for later use. It also produces bile which breaks down fat molecules.

   b. Answers may vary. Enzymes are catalysts required for most of the chemical reactions happening in living cells. Enzymes could include ptyalin in saliva which lubricates and changes starch into sugar. Pepsin produced in the stomach breaks down protein. The small intestine receives the enzymes trypsin, amylase, and lipase secreted by the pancreas which continue to digest or break down protein and fats.

2. Answers may vary. It is very difficult to live without consuming sugar in most processed foods. The label could identify any of the following sugars: sugar, dextrose, sucrose, lactose, maltose, fructose, corn syrup, invert sugar, molasses, maple syrup, honey. Sugar-free alternatives would not list the sugar forms.

3. a. Answers may vary. In general, ingredients are listed by weight with the largest amount first. Lesser amounts of the other ingredients are listed next. Food nutrients in terms of energy, protein, vitamins and minerals may also be listed.

   Answers may vary. For example, the nutritional information appearing on a box of a certain cereal box appears as Brand A includes:

Brand Name	Brand A: An example is given.	Brand B:	Brand C:
Serving Size	30 g		
Main Ingredients	100% whole wheat		
Energy Total	430 kJ		
Protein Total	2.5 g		
Carbohydrates Total	46.7 g		
Fat Total	0.3 g		
Sodium Total	5 mg		
Vitamin Total	varies		
Iron Total	28% R.D.I.		

   Note: R.D.I. – Recommended Daily Intake

   b. Answers may vary. Generally, the main ingredients are wheat, rice, or corn flour.

c. Answers may vary. Portion sizes are usually 250 mL or 30-40 g.

d Answers may vary. Cereals with high amounts of sugar and fat added have the most energy.

e. Answers may vary. Cereals high in nutrients include all parts of the grain not just the flour (starch). Usually cereals that need preparation like rolled oats are more nutritious than cold ready-to-serve cereals.

Section 2: Activity 1

1. Dmitri does work by lifting the fork with spaghetti from the plate to his mouth. Force is applied on the fork to collect a small quantity of spaghetti on the tines and move it through a distance from the plate to his mouth.

2. Shannon may be exhausted from intensive studying, but unless she applied a force through a distance for five hours, she probably did not do much work as defined. Her only work could be a result of flipping pages, writing notes, or snacking, but it could not be a result from using her mind to concentrate.

3. Habib does work as he irons his clothes. By exerting a force on the iron to hold it and move it through a distance over the fabric, work is being done.

4. Although David, Holly, and their dad spent an entire day and a great deal of energy trying to move a huge stone found in the middle of the family farm field, work was not done if they were unsuccessful in moving the stone. They were probably exhausted from applying a force but the force did not move through a distance.

5. The energy obtained from eating the meal is 1280 + 250 + 920 + 1200 = 3650 kJ.

6. Eating french fries with gravy would add (2435 – 920 =) **1515** kilojoules to your meal.

7. a. The number of calories in a cheeseburger is 1280/0.0042 = 304 762 calories.

   b. The number of calories in a vanilla milkshake is 1200/0.0042 = 285 714 calories.

   c. These calculations involve large numbers.

8. a. The number of Calories in a cheeseburger is 304 762/1000 = 305 Calories.

   b. The number of kilocalories in a vanilla milkshake is 285 714/1000 = 286 kilocalories (or 286 Calories).

9. A deluxe hamburger having 2520 kilojoules has 2520 kJ/4.2 = 600 Calories.

10. The number of Calories in the selected meal is 5395 kJ/4.2 = 1285 Calories (1 Calories = 4.2 kJ).

Section 2: Activity 2

1. The water container in a bomb calorimeter is well-insulated to prevent exchange of heat between the calorimeter and the surroundings.

2. The temperature of the water inside a bomb calorimeter is measured before and after a food sample is burned inside the reaction chamber to determine the temperature change resulting from the energy released by the sample.

3. The energy absorbed by the water inside a bomb calorimeter is equal to the energy released by a food sample burned inside the reaction chamber because the same energy was transferred from substance to another. The law of conservation of energy states that energy cannot be created nor destroyed, but it can be transferred from one substance to another.

4. If the initial temperature of water is 22.0°C and the final temperature of water is 31.2°C, the temperature change is 31.2°– 22.0° = 9.2°C.

5. The heat produced by the combustion of a marshmallow sample when 1.00 kg of water rises from 22.10°C to 24.60°C is calculated as follows:

   $$\begin{aligned}\text{heat energy} &= m\Delta tc\\ &= 1000\text{ g} \times 2.50°\text{C} \times 4.2\text{ J/g}\bullet°\text{C}\\ &= 10\,500\text{ J}\\ &= 10.5\text{ kJ}\end{aligned}$$

   The heat energy is 10.5 kilojoules.

6. The heat produced from burning a meat sample causing 1.00 kg of water to rise from 25.20°C to 28.80°C is calculated as follows:

   $$\begin{aligned}\text{heat energy} &= m\Delta tc\\ &= 1000\text{ g} \times 3.60°\text{C} \times 4.2\text{ J/g}\bullet°\text{C}\\ &= 15\,120\text{ J}\\ &= 15.1\text{ kJ}\end{aligned}$$

   The heat energy is 15.1 kilojoules.

7. Polystyrene is a suitable material for constructing a simple calorimeter because it is an excellent insulator of heat. For example, it is used to insulate buildings and refrigerators.

8. The purpose in using the bottom polystyrene cup is to provide additional heat insulation by the trapped air. This is similar to the dead air space between two panes of glass in a window or the fibres in fibreglass insulation.

9. a. The purpose of the water is to absorb the heat released by the sample.

   b. The upper cup is usually filled with 100 mL of water because 100 mL of water equals 100 g of water at 4°C, when water reaches its maximum density. At room temperature the difference is only slight.

10. One limitation that you would encounter in using a simple calorimeter such as this one to determine the energy of a food sample would be the difficulty in burning the food sample inside the water.

11. a. – d. Energy calculations based on the data obtained in the observations table will vary. A large experimental error is to be expected due to energy transfers, mass of sample, and the type of calorimeter used.

12. The peanut should have the most energy.

13. The peanut has a high fat content and should release almost twice the energy of the popcorn which is a carbohydrate.

14. Some reasons for a large discrepancy in the energy content of foods between the actual values and the ones that you observed in the investigation could include the fact that the calorimeter absorbed heat from matches in addition to burning food, the surroundings transferred heat to the calorimeter, and the food samples were not a standard mass.

15. Heat energy stored in various foods can be measured using a calorimeter. It is a device which measures temperature changes in a given mass of water from energy which is released or absorbed by the substance tested. You can calculate the energy that each substance possesses by multiplying the mass of water by the temperature change by the heat capacity for water.

16. You should expect to obtain about half the amount of energy from a carbohydrate compared to an equal amount of fat.

17. The control variable in the experiment was the use of the same mass (100 g) of food for each tested sample.

18. The manipulated variable in the experiment was the type of food selected for testing.

19. The responding variable in the experiment was the amount of energy released by the food samples.

Section 2: Activity 3

1. When a speeding car is involved in a collision with a pole, the kinetic energy of the speeding car is changed into potential, sound, and heat energy.

2. When a waterfall or running water produces electricity by turning an electric generator, its kinetic energy is changed into mechanical, sound, and electrical energy.

3. When wood is burned in a fireplace, its chemical energy is changed into light, sound, heat, and potential energy.

4. When gasoline burns in a car engine, chemical energy is changed into kinetic and heat energy.

5. Answers may vary but common examples where objects are said to possess kinetic energy could include the following:

   - any object in flight such as a baseball, bullet, airplane, bird, or kite
   - any object in motion such as a flowing river, wind, road traffic, train, or avalanche

6. A stretched rubber band is considered to possess potential energy because its position has changed or it now has stored energy capable of being released.

7. Answers may vary but common examples where objects are said to possess potential or stored energy could include such examples as a dammed-up water supply, a boulder on a mountain top, gasoline, a battery, a skier about to attempt a ski jump, and a bullet about to be fired.

8. The car on the top of the hill exhibits potential energy because its higher level position can change to a different or lower level.

9. The car on the top of the hill exhibits potential energy because it has the potential to roll down the hill. In going to the bottom of the hill, when the car is in motion, the car has converted its potential energy into kinetic energy.

10. a. The match inside a packet has potential energy until it is lit.

    b. Water running from a tap is moving; therefore it has kinetic energy.

    c. A stretched elastic band has stored energy or has changed its position; therefore it has potential energy until it is released.

    d. The nutrients in a glass of milk are potential or chemical energy until they are converted through body respiration.

    e. A singing bird produces air vibrations, a form of kinetic energy changed into sound.

    f. The chemicals in a new 9-volt alkaline battery are stored as chemical potential energy.

11. Nuclear energy is produced on Earth in nuclear reactors for generating electricity.

12. Answers may vary, but common examples where light energy is produced could include the following: fire, car headlights, flashlight, lamp, electric bulb, stars, fireflies.

13. Answers may vary, but common examples where heat energy is produced could include the following: fire, motors, sun, chemical reactions, furnace, impact, friction.

14. Nuclear energy is considered a threat by many people if its use is for nuclear weapons capable of vast destruction.

15. Nuclear energy is beneficial to mankind when used for the following:

    - electricity production
    - medical use – radioactive isotopes such as cobalt-60 are used in treating cancer

16. Answers may vary, but common examples that depend on sound energy could include the following: the telephone, musical instruments, conversation, thunder, a falling tree, TV, radio, a barking dog.

17. The sources of sound energy include the people, TV set, telephone, traffic, doorbell, drums, and food mixer.

18. Sound is generally beneficial to most people as indicated by those who lose the ability to hear, but very loud noises such as thunder, jets, and loud music could be irritating or even painful.

19. Answers may vary, but common examples that depend on electrical energy could include the following: appliances, motors, computers, calculators, artificial lighting, radio and TV broadcasting.

20. Mechanical energy is illustrated by bicycle-riding, painting, and cutting the hedge. People got their energy from food, a form of chemical energy.

21. Mechanical energy powers a lawnmower or car. The energy comes from gasoline, a form of chemical energy.

22. These are some different forms of energy found in the illustration:

    - Sound energy comes from the portable stereo and the people.
    - Electrical energy powers the portable stereo.
    - Chemical energy is produced from human respiration.
    - Light energy must be there for the people to see their surroundings.
    - Mechanical energy moves the tapes and moves body joints.
    - Heat energy is generated by the dancing bodies, the moving parts in the equipment, and the flow of electrical current.

23. Electrical energy is changed into heat energy when toast is made. Chemical energy is converted into heat energy when charcoal briquettes are burned.

24. Mechanical energy is represented by the examples because moving parts are involved. These parts are either moving or capable of moving.

25. a. The form of energy that the radio represents is electrical energy which converts the radio waves to sound energy.

    b. Your eardrum vibrates from the sound waves it receives from the radio and this is translated into auditory messages by your brain.

    c. The forms of energy represented by this activity could include sound, electrical, and heat energy.

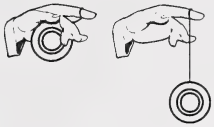
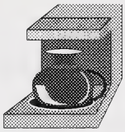
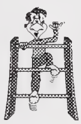
26. Water behind a dam is a form of potential energy due to its position. When it is released, it is changed into kinetic energy. This becomes mechanical energy as the generator is operated in the hydroelectric plant. The generator produces electrical energy.

27. When wind moves a sailboat across a lake, one object (the wind) transfers its kinetic energy to another object (the sailboat).

28. When a program is broadcast on television, electrical energy is changed into sound, light, and heat energy.

29. When clouds are produced, solar energy changes the potential energy of water into kinetic energy as the water molecules move upward. Clouds contain kinetic energy if they are in motion. They contain potential mechanical energy which becomes kinetic mechanical energy during a falling rain.

30.

Example	Original Energy Form	New Form of Energy
yo-yo 	gravity potential	kinetic
coffeemaker 	electric potential	heat
telephone 	electric potential	sound
climbing a ladder 	chemical from glucose	mechanical and heat
lightning 	electrical	light and heat

Section 2: Activity 4

1. Energy in kilojoules can be converted to megajoules by dividing kilojoules by 1000 (1 MJ = kJ/1000).

2. Natural gas and propane have the highest amount of heat energy per kilogram.

3. Wood and coal have the least amount of heat energy per kilogram.

4. Fuel oil provide almost three times as much heat energy per kilogram as wood.

5. Propane is becoming more popular as a fuel for trucks and cars because it releases about 15% more heat energy per kilogram than gasoline. The cost for propane conversion may offset its lower operating cost.

6. The fuels could be burned in a calorimeter. The amount of energy could be calculated using the energy absorbed by a measured mass of water, its temperature change, and heat capacity.

7. The water in Glass D should get the hottest.

8. Heat is converted from radiant solar energy. It is absorbed by the black paper, reflected by the aluminium foil, and transferred to the water.

9. Aluminium foil is put behind Glass D so that it can reflect radiant solar energy to the black paper which absorbs it. Aluminium foil reflects heat.

10. Dark surfaces such as black paper absorb heat; shiny surfaces such as aluminium foil reflect heat.

11. On a hot summer day, the temperature inside an automobile is much greater than outside because a dark surface such as the car interior absorbs heat and the glass reflects heat back inside the car.

12. Answers may vary, but assuming that the rise in temperature per minute remains the same, the length of time it would take for the temperature to reach the boiling point of water (100°C) would be

$$\frac{100^\circ\text{C} - \text{starting temperature in } ^\circ\text{C}}{\text{rise in temperature per minute}} = \text{time required in minutes}$$

13. Black paper ignites faster than white paper because black surfaces absorb heat and white surfaces reflect it.

14. When bottles are thrown out of a car window they can start forest fires if the bottles break. Broken bottle glass has a curved surface much like a concave mirror. This surface can focus sunlight on a combustible material.

15. The tilt or angle of the collector, the latitude or amount of sunshine received, and design are some factors determining the maximum amount of solar energy that can be gathered by a typical high technology collector panel.

16. Buildings that rely on solar energy generally have a dark or black-coloured roof, mechanical equipment, and circulating pipes to increase the amount of radiant energy absorbed.

17. The construction design of a solar dependent house differs from a conventional type of residence in the extensive use of a sloping exterior and windows on the roof and walls for capturing maximum sunlight.

18. The high cost of solar collector panels and the mechanical devices needed for energy transfers may be a limiting factor for solar energy dwellings in northern climates. Alternate conventional energy resources may be still be required for winter months.

19. Curved parabolic mirrors or shiny surfaces are often used to design solar collector ovens and cooking devices because they reflect and focus solar energy. The devices would be most popular in tropical areas receiving large amounts of sunshine.

20. A bank of silicon solar cell collectors to change solar energy directly into electricity is used in satellites and remote telecommunication stations.

21. The tuning fork produces a musical sound.

22. The water produces a series of circular small waves or ripples from the point in which the tuning fork touches it to its outer edges, similar to what happens when a rock is thrown into water.

23. The small amount of sand or salt particles from a shaker begins to vibrate or move on the surface of the plastic wrap.

24. It would be difficult to make measurements of the frequency or vibrations per second created with a tuning fork in this investigation because the number of vibrations per second are too numerous to count.

25. This does not mean that frequency measurements for this investigation cannot be made. It only means that a method would have to be found to count the numerous vibrations per second rapidly and accurately.

26. Frequency measurements for this investigation could be made by using electronic equipment capable of counting numerous vibrations per second.

27. Musicians and many people who listen to loud music could develop hearing problems from the very powerful sound energy produced by amplified music. Powerful eardrum vibrations may be excessive and cause damage.

28. One precaution that people could take when they work in a noisy environment is to wear ear protection.

29. Answers may vary, but possible areas where sound can cause damage to your ears could include the operation of explosives, weapons, or the jackhammer and heavy machines, or nearness to aircraft take-offs or rocket launches.

30. Answers may vary, but sources of sound with a decibel rating above 120 dB could include explosions, thunder, avalanches, earthquakes, volcanic eruptions, or rocket lift-offs. The noise would be very loud and painful to the ears.

31. Answers may vary, but environments with a decibel rating below 40 dB could include libraries, a classroom during an exam, a house or hospital at night, a detention room, and a funeral home. Sources of sound with a decibel rating below 40 dB could also include a sleeping animal, a purring cat, a book page being turned, walking on carpeted floor, a wrist watch or electric clock ticking, heart beating, and some insects flying.

32. Answers may vary, but a predicted noise level of about 30 to 50 dB in a classroom during an exam or library use is not unusual. This is less than a reading of 60 dB for conversation which would be minimal during an exam or library use, but above a whispering level. Sounds would still be made by people coughing or shuffling feet or by outside traffic noise coming into the room.

33. Answers may vary, but a predicted or estimated noise level or decibel reading of about 70 dB would be an expected average that you would encounter on a daily basis. It is above the conversational level but below the noises that are rated above the 80 dB reading that you live with on an occasional basis.

34. A fluorescent lamp is more efficient than an incandescent light bulb because it gives more lumens per watt.

35. Static electricity is produced by friction, such as walking on a carpet, which builds up a negative charge. When a person touches another, the negative charge is discharged resulting in a shock.

36. a. If two magnet polarities are different, the magnets will be pulled together.

    b. If the two magnet polarities are similar, the magnets will be pushed apart.

37.

Charges	Attract	Repel
+ –	✔	
– –		✔
+ +		✔
– +	✔	

38. The energy that a 100 watt light bulb uses in 1 hour may be calculated as follows:

$$\begin{aligned} \text{Energy} &= \text{power} \times \text{time} \\ &= 100\ \text{W} \times 3600\ \text{s} \\ &= 100\ \text{J/s} \times 3600\ \text{s} \\ \text{Energy} &= 360\,000\ \text{J or } 360\ \text{kJ} \end{aligned}$$

The energy used is 360 kJ.

39. The reading of the meter in May is 12 011 kW•h.

40. a. The number of kilowatt-hours of electrical power that was used between April and May is 12 011 – 11 690 = 321 kW•h.

b. The cost of power consumption based on the meter reading is 321 kW•h × \$0.17/kW•h = \$54.57.

c. The cost of power consumption during the winter months would be higher; the cost during the summer months lower. Cold temperatures and fewer daylight hours during winter increase the demand for power. Warmer temperatures and more daylight hours would decrease power demands, unless air conditioning is used.

41. The 1500-watt hairdryer has the most power. It probably is the better buy because it delivers more power for only two dollars more.

42. Answers may vary, but assuming a power source of 1.5 V and 8 A, the light bulb uses 12 W of power.

$$\begin{aligned} \text{Power} &= \text{current} \times \text{voltage} \\ \text{W} &= 8\ \text{A} \times 1.5\ \text{V} \\ &= 12\ \text{W} \end{aligned}$$

43. Answers may vary but could include a 60- or 100-watt bulb in a table lamp, a 40-watt bulb in the hallway, and a 25-watt lightbulb inside an oven.

44. Answers may vary but could include examples such as the following:

appliance:	electric kettle	iron
model #:	EK 200	HD 1613/K
voltage:	120	120
watts:	1500	1200

45. Answers may vary, but if your hairdryer is rated at 1000 watts, the energy used in one-half of an hour would be calculated as follows:

$$\begin{aligned} \text{Energy} &= 1000\ \text{J/s} \times 1800\ \text{s} \\ &= 1\ 800\ 000\ \text{Joules} \\ &= 1\ 800\ \text{kJ} \\ &= 1.80\ \text{MJ of energy} \end{aligned}$$

The hairdryer would use 1.80 megajoules of energy in one-half of an hour.

46. A 100-watt bulb that is on for 10 hours uses $100\ \text{W} \times 10\ \text{h} = 1000\ \text{W}\bullet\text{h}$ which equals 1 kW•h.

47. A 200-watt bulb should be much brighter than a 40-watt bulb.

48. The bright lights of a city are essential due to heavy traffic and pedestrian flow, crime prevention, and the provisions of a visible environment for hospitals and other places of employment.

Section 2: Follow-up Activities

Extra Help

1. a. seafood – poached fish, halibut, sole, trout, shrimp

   b. poultry – skinless roast chicken, turkey

   c. fresh berries – strawberries, blueberries

   d. low fat dairy – yogurt, skim milk

   e. gelatin – sugar-free jelly powders

2. a. A ballerina dancing uses chemical energy obtained from food.

   b. A growing tomato plant uses light energy to form chemical energy.

   c. A TV turned on uses electrical energy but converts it into sound and light energy.

   d. A pot of boiling water uses heat energy to produce sound energy.

   e. A power plant for electricity may use chemical energy (from coal or natural gas) or nuclear energy to produce sound, heat, mechanical, and electrical energy.

   f. A saw cutting wood uses mechanical energy to produce heat energy from friction.

   g. A jackhammer working uses electrical or chemical energy (obtained from gasoline) and produces mechanical, heat, and sound energy.

3. Foods high in energy due to a high fat content are cheese, ice cream, bacon, butter, potato chips (fat fried), and banana cream pie; those due to a high carbohydrate or sugar content are the canned pop and chocolate.

4. All forms of energy can be associated with the sun.

5. Answers will vary. Appliances in the kitchen may include stove, refrigerator, toaster, kettle, mixer, coffeemaker, blender, waffle iron, popcorn popper, slow cooker, electric wok, frying-pan, can opener, etc. Light bulbs are found on the ceiling, and in the oven, refrigerator, microwave, etc. The total number of watts that would be used is based on the ratings of the appliances or bulbs selected.

   a. The total number of kitchen watts is based on the ratings of the appliances or bulbs selected.

   b. Divide the total number of watts by 1000 to get kilowatts of power used.

   c. Multiply kilowatts of power used by 1 hour to get the number of kilowatt hours kW•h of electrical energy is used.

Enrichment

1. Answers may vary but could include ideas such as the following:

   - Most appliances with heating elements require constant power, are rated at about 1000 to 1500 watts, and generally consume the most energy.
   - Motors consume more energy at startup than during their running time.
   - Cost is based on the length of time the appliance or motor depends on energy and its rating.

2. Answers may vary. Check a previous meter reading as shown on your power bill to determine electrical energy used and its cost.

3. Use the table in the Appendix to find out how many kilojoules per hour are used in bike riding, walking, running, or swimming.

4. Answers may vary but could include ideas such as the following:

   - Lighting may appeal to prospective customers.
   - Light levels may influence your shopping in a particular store.
   - Merchandise may appear to be a higher quality than it actually is under effective lighting and display.
   - Numerous light fixtures highlight display of merchandise and can be compared with displays having less lighting.

Section 3: Activity 1

1. Answers may vary, but common examples where large amounts of energy are used for non-essential goods or services could include such examples as arcades, luxury resorts, amusement parks, advertising flyers, plastic packaging, manufacture of limousines and luxury cars, and luxury accommodations.

2. Answers may vary, but common examples where fossil fuel energy is used could include cars, planes, trains, producing plastics and chemicals, heating of homes and buildings, factory manufacturing, and industrial processes.

3. Answers may vary, but common examples where energy is wasted could include unnecessary lighting or leaving lights on, printing and distribution of coloured junk mail, and disposable plastic containers, wrappers, and diapers.

4. Fossil fuels are considered as a nonrenewable energy source because once they are consumed they cannot be replaced.

5. Answers will vary. The kilojoules of energy you need each day based on the graph depend on your age and sex.

6. The kilojoules of energy you need to stay at your present mass depends on your weight. If you weigh 60 kg, for example, you would require 140 kJ/kg $\times$ 60 kg = 8400 kJ.

7. The factors that would increase or reduce the number of kilojoules of energy your body needs depend on your activity, growth, genetic factors, and BMR. You may reduce your energy requirement if you are ill or very inactive. You may increase your energy requirement if you are highly active in sports or strenuous exercise.

8. Male teens (15-year-old boys) require the most energy due to muscular development or growth. They also tend to have a higher rate of metabolism than females.

9. Your basal metabolic rate depends on your weight. For example, if you are 60 kg your BMR is 4.2 kJ $\times$ 60 kg $\times$ 24 hours = 6048 kJ/day.

10. Your total energy output depends on the activities you select from the table which are then totalled. Generally, an average 16-year-old male uses 12 000 to 15 000 kJ and a female uses 11 000 to 14 000 kJ.

11. If you plan to lose weight, your diet would differ in terms of what and how much you eat.

12. If you plan to lose weight, some form of exercise would need to be included in your energy output.

13. Your total energy output depends on the activities you select and their energy values.

14. Your total energy input depends on the foods you eat and their energy values.

15. You may be eating more or less kilojoules of food energy than you use. Is your energy input less or more than the output?

16. Some people do not gain weight by taking in too many kilojoules of food energy due to genetic factors or a tendency to burn food faster than others.

17. Other uses in the home that depend on hot water include washing of dishes and clothes.

18. Gadgets in the home that consume energy could include such items as a TV, radio, compact disc player, tape recorder, computer, electronic games, and electric scissors, knives, razor, clocks, and pencil sharpener.

19. a. B

    b. B

    c. E

    d. B

    e. B

    f. E

    g. E (also gasoline, but not natural gas)

    h. B

    i. B

    j. B

20. The furnace is probably the most expensive user of natural gas in your home.

21. People in Central Canada generally use oil to heat their homes.

22. Two factors that affect the amount of electricity used by appliances are the following:

    - the wattage or power rating for each appliance in operation
    - the length of time they are used

23. The appliance from the table which uses the most energy is the water heater.

24. a. Answers may vary, but if you chose a vacuum cleaner, for example, the watts per month would equal 800 W/mo, the time used per month would equal 8 h/mo, and the kilowatt-hours would be 800 W/mo $\times$ 8 h/mo = 6400 W•h = 6.4 kW•h.

    b. Answers may vary, but the appliance using the most energy for the longest time period would have the largest kW•h.

25. a. Add 30 kW•h of energy to the answer you obtain. This gives you the total for one month.

    b. You would multiply eight cents per kilowatt-hour by the number of kW•h you obtained in the previous question.

26. Your table could include the following title and column headings:

    Title: Meter Readings Every 24 Hours For 1 Week

Time of reading	First reading in kW•h	Second reading in kW•h	Power used

27. Any logical reason for a large usage on a particular day is acceptable, for example, an air conditioner may have been used on a very hot day.

28. The number of kilowatts that were consumed over the 7-day period are based on your lifestyle.

29. You would multiply the cost of electricity per kW•h by the number of kilowatt-hours plus any additional charges that the utility company uses.

30. Answers will vary. Are you able to locate all the items?

    a. The previous month's usage in kilowatts should be recorded on the electrical utility bill.

    b. The current month's usage in kilowatts should be recorded on the electrical utility bill.

    c. The number of kilowatt-hours of electricity that was used should be recorded on the electrical utility bill.

    d. The power bill for the month should be recorded on the electrical utility bill.

Section 3: Activity 2

1. The heating of homes and buildings is the largest consumer of energy in Alberta due to the cold winters.

2. a. Any three areas in your house or school that are likely sources for heat loss are leaky doors and windows, cracks around foundations, and poor insulation. One way to tell what areas lose heat is to have a professional assessment made, but you may be able to detect drafts or make your own subjective evaluation systematically area by area by using a checklist.

   b. The possible solutions for the heat losses you identified would be to use proven methods and make necessary improvements for areas identified.

3. Areas where energy is wasted could include the following:

   - The opened door lets cold air in and warm air out. It should be shut.
   - Lights not being used are left on. They should be off.
   - No one is watching the TV which is on. It should be shut off.
   - The small pot on a large burner is wasting heat and electricity. A smaller element should be used.
   - The milk carton is left outside the refrigerator allowing it to warm up. It should be put back into the refrigerator.
   - Heat registers are not strategically placed or are in areas of greatest escape. They should be relocated away from windows and entrance ways.
   - The coffee pot is plugged in and heated over an extended period. It should be reheated as needed.
   - Food on the counter could spoil and be wasted. It should be refrigerated.
   - The fridge door is ajar, allowing cold air to escape. It should be shut.

4. Energy could be wisely used in the following ways:

   - Install storm doors.
   - Weather-strip doors and windows.
   - Close window drapes at night.
   - Insulate walls and attic.
   - Return beverage containers to depot.
   - Use the blue box recycling program or encourage its practice.
   - Turn off lights and appliances when not used.
   - Recycle kitchen waste into compost.
   - Keep refrigerator door tightly closed and sealed.
   - Install double or triple glazed windows.
   - Maintain household repairs.
   - Use high-efficiency light bulbs.

5. a. **T**

   b. **T**

c. **F** Incandescent lights consume more energy.

d. **F** Toasting one slice of bread at a time in a toaster wastes energy.

e. **F** Washing dishes consumes less energy than using throw-away containers, plates, and cutlery.

f. **F** Waterskiing, motorboating, and snowmobiling do consume a great deal of energy.

g. **F** Having your car tuned-up reduces fuel consumption.

h. **F** You would save money by switching a truck fuel tank to propane since propane supplies more energy.

i. **T**

j. **T**

Section 3: Follow-up Activities

Extra Help

1. The amount of energy used would equal BMR + energy used in activities.

$$\begin{aligned}
\text{Your BMR} &= 6000\ \text{kJ} \\
\text{Soccer} = 1160 \times 2 \times 2\ \text{h} &= 4640\ \text{kJ}\ (1160\ \text{kJ/30 min}) \\
\text{TV viewing} = 420 \times 2\ \text{h} &= 840\ \text{kJ}\ (420\ \text{kJ/hr}) \\
\text{Total} &= 11\,480\ \text{kJ}
\end{aligned}$$

2. High energy activities could include such activities as vigorous swimming, cross-country skiing, soccer, hockey, and running.

3. a. The meter reading in kW•h during May is 5467 kW•h.

   b. The meter reading in kW•h during June is 6345 kW•h.

   c. Electricity used in one month is 878 kW•h.

4. The following products are excessive energy consumers as they represent an extravagant lifestyle:

   - pizza delivery
   - drying one shirt in the dryer
   - keeping the room temperature at 22°C
   - energy used at a rock concert
   - flying a private jet
   - using the oven to heat a room
   - buying an assortment of cosmetics

Enrichment

1. The fuse has a thin strip of metal that melts at a low temperature when too much electricity passes through the circuit. This breaks the circuit and protects against electrical fires that could result if the current met a high resistance to its flow.

2. Many fad diets only approximate the essential nutrients but do not contain the requirements obtained from a wide variety of nutrients that a balanced diet provides.

3. a. Count all the fluorescent lights in your classroom and multiply the number by 40 W by one hour to get watt-hours. Divide this number by 1000 to get kW•h.

   b. Multiply the number of kW•h by eight cents per kilowatt-hour to get the cost.

   c. If lights were turned off during lunch hour the saving in one month would be the number of school days in the month multiplied by the number of kW•h by eight cents per kilowatt-hour.

4. Appliances containing the Energy Guide label on them include refrigerators, stoves, dryers, and washing-machines. Your survey should include several different models for a comparison to find the most energy efficient model.

5. Use the energy guide on labels of three appliances and multiply the number of kW•h by the charge per kilowatt hour as charged by the utility company to get the cost per kW•h. Use the average monthly power rating in the Electrical Appliance Power Rating chart in the module. Multiply this number by the cost per kW•h by twelve months to calculate the amount of electricity the appliances use for one year.

6. The cost of running appliances with heating elements is generally higher than those with motors. Initially motors need a surge of electricity to get them running but overall, require less than heating elements. Both need a constant supply of electrical energy.

7. To monitor the energy consumption in your home you would need the cooperation of family members.

   To monitor the energy consumption in your school for one month you would need the cooperation of the principal or school board for the information. You would have to devise an improved system for using energy in your school before you approach school officials for this information.

8. The efficiency of a 40 W fluorescent lamp is about three to four times that of incandescent lamps in terms of brightness (lumens). If both bulbs are 40 W their power rating is the same, but a fluorescent bulb converts less electrical energy to heat energy than does an incandescent lamp. Incandescent lamps become quite hot compared to fluorescent bulbs.

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